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Cedar Hill Engine House Facilities, New York, New Haven and Hartford R.R.*

By J. M. Sullivan, Jr.†

The New York, New Haven & Hartford R.R. Co.'s engine house facilities under construction at Cedar Hill, New Haven, Conn., are located on the west side of the Quinnipiac River and north of the Air Line track, about three miles in an easterly direction from the New Haven passenger station. These new facilities include an engine house with a 75-ft. turntable, power house, machine shop, toilet and locker-room building, 1500-ton coaling station and sand drier, engine water supply of four 12-in. water cranes and a 55,400-gal. water tank, two 150-ft. cinder pits with an electric overhead crane equipped with a 1⅝-cu.yd. clamshell bucket, office, store- and oil-room building and an extra turntable with radial tracks located north of the machine shop for a future round house.

Owing to the unfavorable nature of the soil it was necessary to drive wooden piles for the foundations of all buildings and turntables except the coaling station and cinder pits, the former being located on solid ground beyond the old line of marsh, the latter on filled ground overlying about 5 ft. of compact mud. This fill is about 10 ft. deep and has been under constant traffic since the freight yard was built. Soil tests showed that it had a bearing value of about 1½ tons per sq.ft. The marsh level is at elevation +1.0, while the high water in the Quinnipiac River is at elevation +0.5 with a rise and fall of tide of about 6 ft. All elevations refer to the New Haven City datum, 0.0 equaling mean high water in the New Haven Harbor.

Preliminary work was started in November, 1910, this work consisting chiefly of driving test piles and sinking test pits. These tests showed the bog to be about 3 ft. deep, under which was 15 to 20 ft of silt and then a stratum of clay and sand over a bottom of hard clay. Actual work was started in February, 1911.

Engine House

This circular structure 360 ft. in diameter contains 44 stalls, or 43 engine stalls, one being used as an entrance.

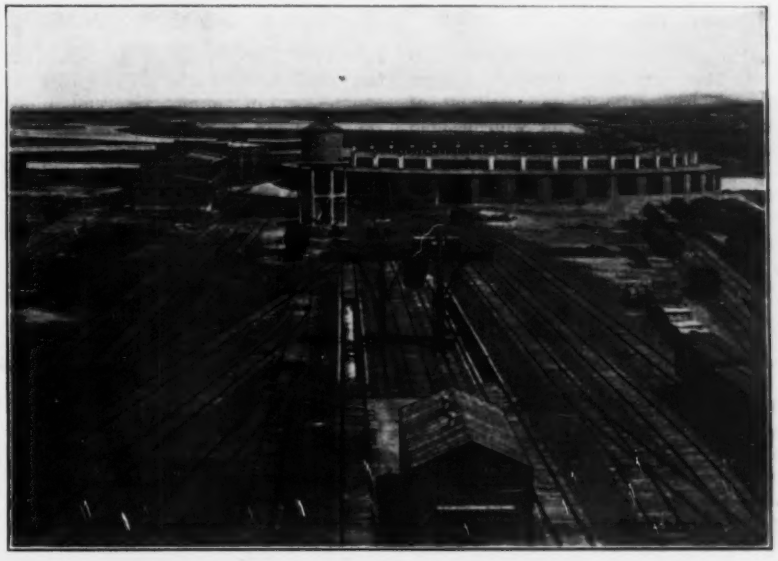
Footings—About 4500 spruce piles 40 to 55 ft. long were driven by means of three gravity pile drivers, one using a hammer of 2200 lb. and two using 3000-lb. hammers. The pile cut off is at elevation +0.5, ½ ft. below the level of the marsh. The piles were driven about 2-ft. centers and each carries a load of between 7 and 8 tons. The nature of the bog is such that the capillary attraction will keep the piles wet to a considerable height above the water surface. A concrete cap 12 in. thick and extending 6 in. below the cut-off was placed over the piles, although in some of the footings it was necessary to place about 6 to 10 in. of cinders in order to form a base for the 12-in. capping, the bog being so soft that the concrete would settle into it before it had time to set (Fig. 4).

Structural Details—The roof at each stall is supported by four concrete columns built on a radial line (Fig. 3). Columns *A* make up the inner ring and are 13 ft. 4 in. on center columns. *B* and *C* are inside the house, while columns *D* make up the outer ring and are 25 ft. 7½ in. on centers. The distance between the centers of columns on the inner and outer ring is 86 ft.

The foundations of the columns are a frustum of a pyramid about 5 ft. square at the base and 16 in. square at the top, which is at elevation +7.0. The space between the columns of the outer ring is arched with a concrete beam reinforced with two 4-in. 60-lb. rails, which supports the brick curtain wall.

The columns which support the roof are 14 in. square and reinforced with twisted rods placed in the corners and hooped with wire. The four corners at the base of the columns are protected by 2x2x⅜-in. angles 5 ft. long, anchored with counter and stove bolts 6 in. long. The roof is of the monitor-type construction, carried in three sections, the middle section or monitor is elevated about 6 ft. above the adjoining sections to provide space for stationary and pivoted sash for ventilating and lighting. The main girders on the radial center line of columns are 14x38 in. deep, reinforced with six ⅞-in. square twisted rods. The roof beams average 6x15 in. deep, reinforced with two ⅝-in. square twisted rods in the bottom and two ½-in. square twisted rods in top at girders to provide for the negative bending moments. The roof consists of a concrete slab 2½ in. thick, reinforced with wire cloth, covered with a five-ply pitch and slag roofing.

The brick walls of the outer ring are 12 in. thick, with an opening 16 ft. square for the windows which are of the box-frame type built in three sections of three sash each, the upper and lower sash being arranged to slide, while the center



General View of the Yard Looking Toward the Engine House

*Prepared from a paper delivered before the Annual Meeting of the Connecticut Society of Civil Engineers, February, 1912.

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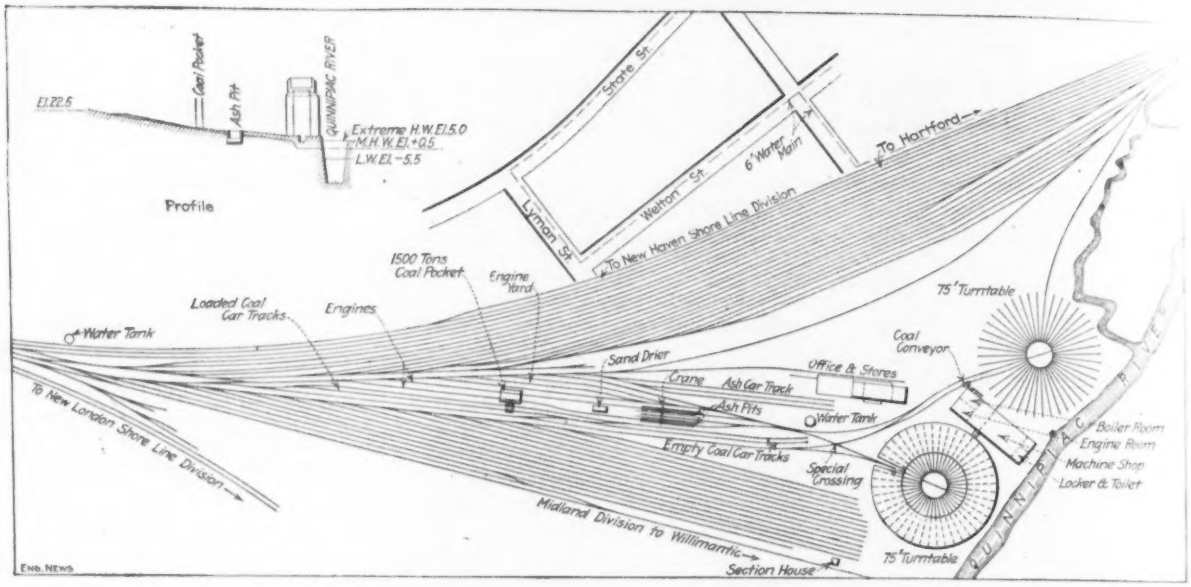


FIG. 1. GENERAL LAYOUT OF ENGINE-HOUSE FACILITIES OF NEW YORK, NEW HAVEN & HARTFORD R.R., AT CEDAR HILL, NEAR NEW HAVEN, CONN.

sash is stationary. The entire inner circle is fitted with wood-slat rolling doors in each bay. The doors are built of Georgia yellow-pine slats with opaque glass panels inserted to give light, and each door is provided with a small swing wicket door, through which entrance may be made to the roundhouse without raising the large door. A continuous line of stationary sash windows takes up the space between the tops of doors and the roof beams. All mullions and sills are of concrete reinforced with square twisted rods.

ENGINE AND DROP PITS—Each of the 43 stalls has a concrete engine pit 62 ft. long by 4 ft. 2 in. wide by 2 ft. 6 in. deep at one end and 3 ft. deep at the other to provide for drainage. Fastened to the top of the concrete pits by means of pipe dowels are 8x12-in. yellow-pine timbers onto which are spiked the 80-lb. rails for the locomotives, while fitted to the outside of the 80-lb. rails and fastened to the pits in the same manner as timbers, under the rails, are placed 5x16-in. jacking timbers. Each pit is drained by a 6-in. pipe which connects with the main drain encircling the house inside of the inner circle, and runs to a main catch basin located inside the turntable ring, from which point it empties into the river (Fig. 6).

Extending across three of the engine pits at stalls 30, 31 and 32 is a drop pit 7 ft. wide by 5 ft. deep, the floor of which is 2 ft. 8 in. below the engine-pit floor. The drop pit at the three points where engines cross is spanned by movable 100-lb. rails which slide on greased-steel plates ¾x12 in. wide, anchored with ¾x16-in. counter-sunk bolts to the top of the side walls and extending the entire length of the pit. A 3-ft. 4-in. gage track built of curved 60-lb. rail runs the entire length of the pit. Hydraulic plunger jacks are installed in the drop pit under each of the three engine-pit tracks. Stall 31, which is located at the center of the drop pit, connects with the machine shop. Locomotives requiring repairs which necessitate the removal of driving wheels, trucks or other heavy parts are run on to one of the tracks crossing the drop pit and by means of the movable rails, plunger jacks and narrow-gage car the various parts may be transferred from the locomotive to the machine shop. A 6-in. I-beam trolley conveyor about 58 ft. long is installed over each of the three engine tracks that cross the drop pit and

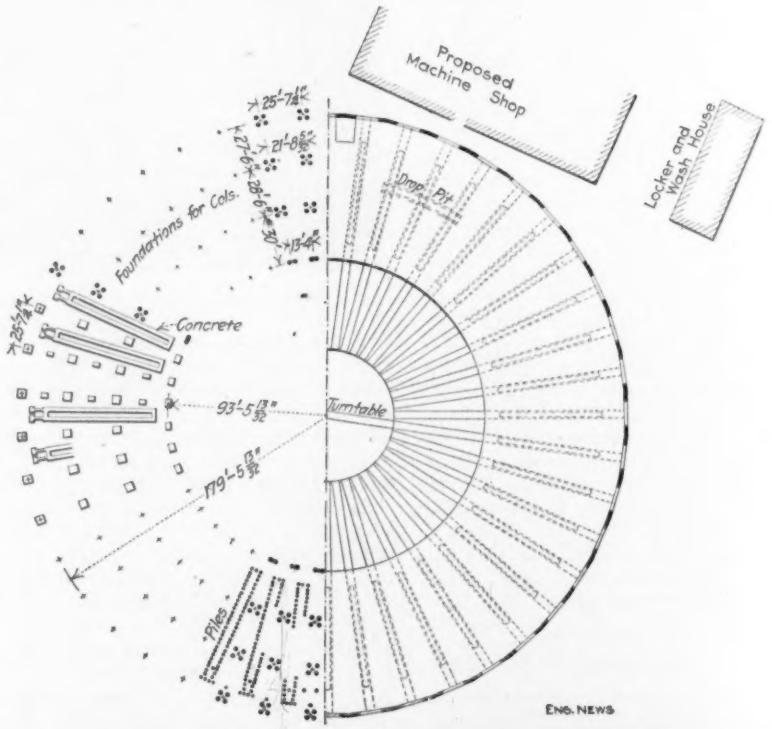


FIG. 2. PLAN OF ENGINE HOUSE, SHOWING FOUNDATION AND TRACK LAYOUT

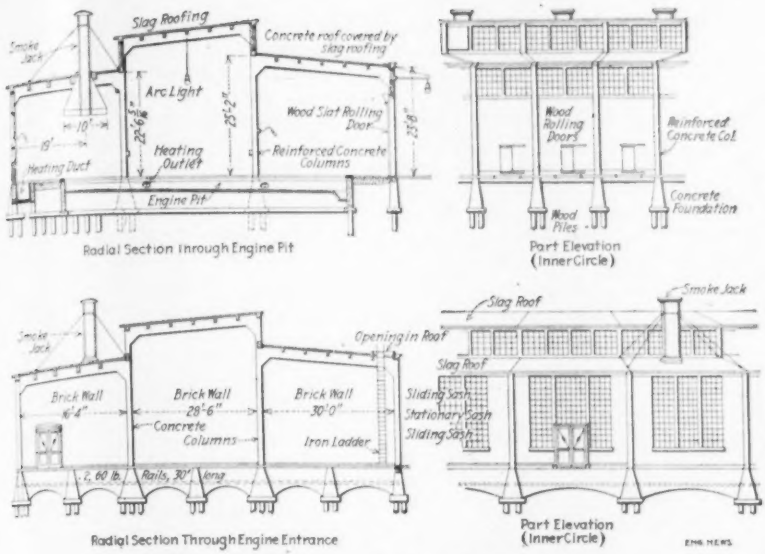


FIG. 3. SECTIONAL ELEVATIONS OF ENGINE HOUSE

are supported by ⅝-in. rods anchored to the concrete roof beams. This trolley is used to remove small parts from the tops of locomotives.

Smoke jacks built of asbestos lumber with wood frames are located over each engine pit. The hoods are 10 ft. long, so that it will not be necessary to have the stack of the locomotive, ejecting smoke, exactly under the center of the smoke jack.

HEATING AND VENTILATING—The building is heated by a hot-air blast system. Two units consisting of a fan, engine and heater are located on separate elevated platforms inside the roundhouse, each unit heating 22 pits. Fresh air is drawn through an opening in the outer brick wall and through the heater which is built up of 8730 lin.ft. of 1-in. wrought-iron pipe into which exhaust steam from the power house will be carried. The air after passing through the heater is forced through the main heat ducts, which are formed of concrete and run each way from the heating apparatus and thence through the branch ducts of round tile to the engine pits. The main duct is lined with semi-porous tile finished on the inside with ½-in. of cement plaster and its size diminishes from the heater connection after each branch duct is passed, by sloping the sides and bottom. The heating apparatus is designed to heat the building to 60° in zero weather. Steam, water and air-pipe mains encircle the entire house near the outer circle with drops at every other engine pit, one set of drops serving two engine pits.

BOILER-WASHING SYSTEM—For saving fuel and labor and shortening the time that would otherwise be used in washing out locomotive boilers and placing same under steam again, a boiler-washing system is being installed. The system consists of one combination heater and storage tank capable of storing and heating about 5000 gal. of water with which to refill locomotives and stationary boilers; one washout tank capable of holding over 11,000 gal. of water consisting of steam and hot water blown off from locomotive and stationary boilers, which water is filtered and used for washing out and refilling them; and one pump and necessary pipes to convey the warm water and steam from the locomotives to the tanks and return. The tanks are located in the

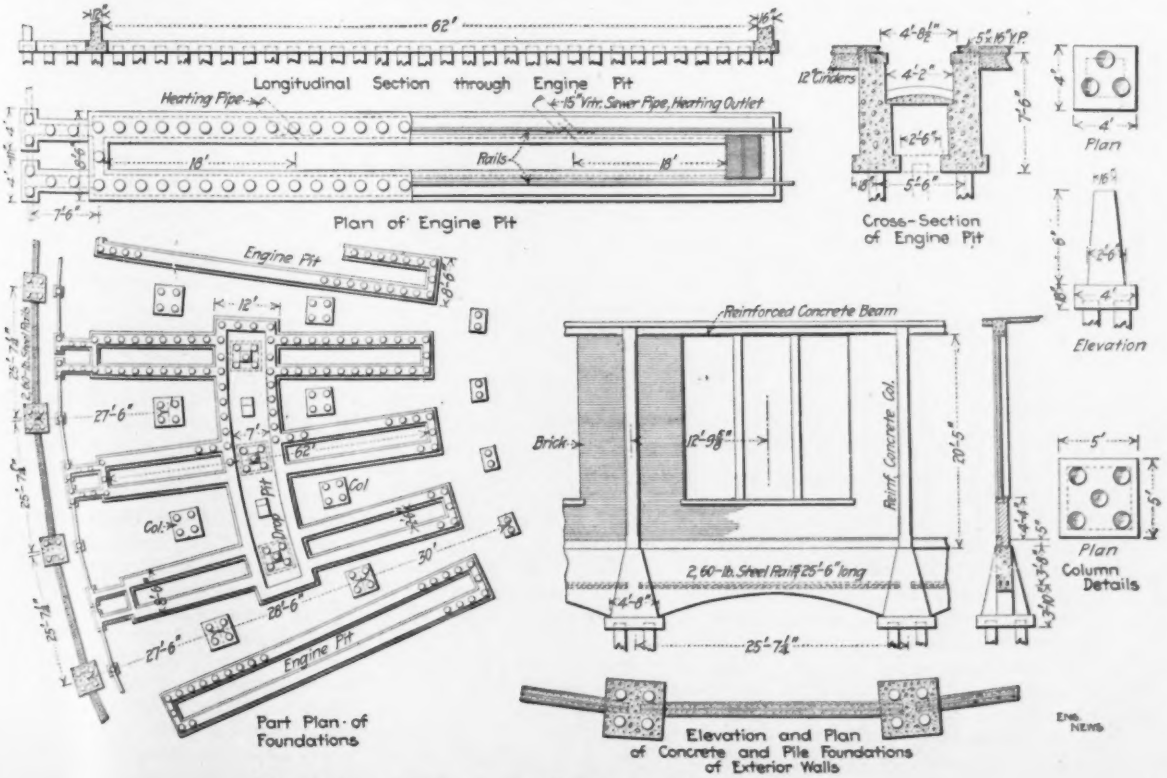


FIG. 4. SOME DETAILS OF THE FOOTINGS OF THE ENGINE HOUSE

boiler room of the power house, with pipe connections to the mains which encircle the roundhouse with drops at every other column so that one set of drops serves two engine pits. The operation consists in blowing off the steam and water from the locomotives through coils in the combination heater and storage tank into the washout tank; the steam and hot water passing through the coils in the storage tank keeps the fresh water in the tank at a high temperature.

A large percentage of the steam passing into the washout tank condenses and the hot water from the locomotives is passed through a strainer box and scale pocket, after which it is pumped back to the locomotive for washout purposes at a temperature of about 140°. After the boiler is cleaned the water from the combination heater and storage tank is pumped into the locomotive boiler at a temperature of about 190°, thus making it possible to start a heavy fire immediately and have the locomotive under steam at short notice.

TURNTABLES—Within the covered ring of the roundhouse is an open area about 188 ft. in diameter, in the center of which is a 75-ft. turntable of the half-through type built of 17-ton girders, which turn on a bronze saddle or bearing at the center. The center bearing is supported on a concrete pier 7 ft. deep, 6 ft. square at the top and 14 ft. square at the base, under which are 49 piles. The ring is of concrete supported on three rows of 93 piles, each about 2 ft. on centers. The turntable will be operated by an electric turntable tractor, driven by a 20-hp. motor operating on a 440-volt 60-cycle three-phase line. The tractor has the capacity of making one complete revolution of the turntable, after acceleration, in one minute or less when turning a locomotive weighing 185 tons.

A similar turntable and tractor has been built north of the machine shop, together with 44 radial tracks, for a future roundhouse.

FILL—Owing to the fact that the floor of the roundhouse is about 7 ft. above the meadow level it required about 30,000 cu.yd. of filling inside of the building, this fill was made chiefly of cinders. The river is about 20 ft. deep at a distance of 15 ft. from the outer wall of the roundhouse, which condition necessitated some steps being taken to prevent the bog from working into the stream when the weight of the fill should be imposed upon it. Accordingly, after the piles had been driven the river bank was rip-rapped with 1000 tons of stone averaging about 1.5 cu.ft. in size, and later, when all concrete work in the house was completed, the fill was worked in from the upper edge of the rip-rap, spreading both ways around the inside of the house from the river. This method seems to have prevented any movement of the bog.

POWER HOUSE, MACHINE SHOP, TOILET AND LOCKER ROOM BUILDING

This building is 251 ft. long by 77 ft. 4 in. wide and is built on concrete piers, about 9 ft. on centers, supported on piles. Spanning between each two piers is a reinforced-concrete beam, and above that the building is built of 12-in. brick walls, with 20-in. square pilasters spaced 18 ft. on centers, supporting the roof

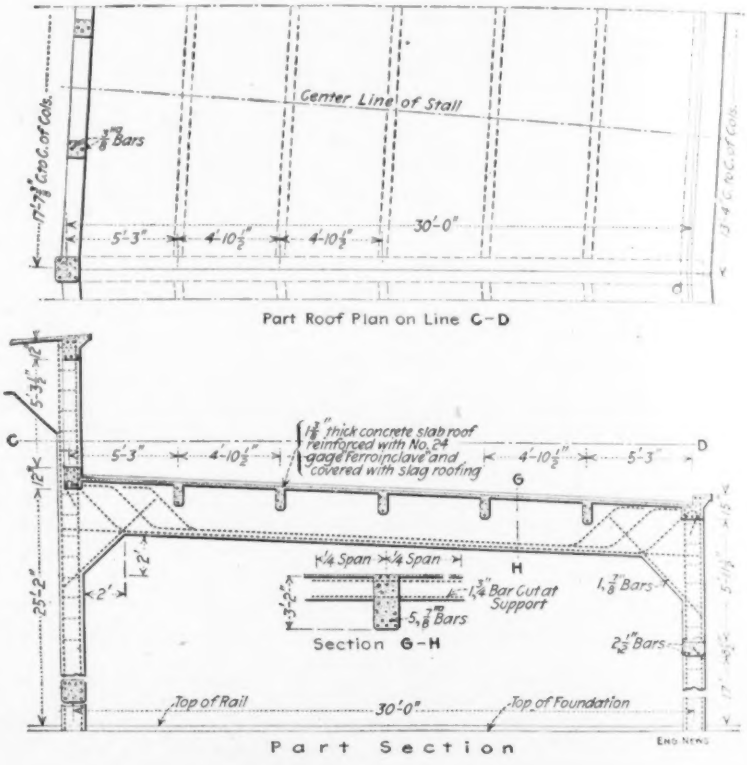


FIG. 5. DETAILS OF A MAIN GIRDER, ENGINE HOUSE

west wall. Under this platform is located the washout and refilling tanks of the boiler-washing system. A covered coal-storage bin is located outside the north wall of the boiler room, the bin having a capacity of 62 tons. A reinforced-concrete receiving hopper has been built under the coal-car track with a beaded flight conveyor running to the storage bin. The conveyor has a capacity of 25 tons run-of-mine coal per hour. Two beams and trusses. The roof over the machine shop is a monitor type construction with wooden trusses 18 ft. on centers spanning the entire width of the building. Wood purlins support the 1½-in. roof boards. The concrete roof over the power house is 2½ in. thick, reinforced with wire cloth and is supported by steel roof beams 18 in. deep, with 12-in. steel channel purlins spaced 6 ft. on centers. Over the entire roof is placed a five-ply pitch-and-slag roofing.

The power house is located in the west end of the building. The boiler room is separated from the engine room by a 12-in. brick wall, giving equal floor space in each room. The boiler room when completed will contain two 500-hp. vertical water-tube boilers, the firing of which will be with automatic stokers. The forced-draft apparatus for the stokers and the induced-draft apparatus for the boilers will be located on an elevated platform between the boilers and the openings 3 ft. square with drop doors are built in the north wall of the power house, through which coal is handled from the bin to the stokers. The engine room when completed will contain two 225-hp. engines and two 185-kv. generators, which will generate the electricity to be used for light and power about the buildings and yard, and one 2000-cu.ft. air compressor together with necessary switchboard, etc. The steam, air and boiler washout-system pipes are carried overhead on a steel channel bridge from the power house to the roundhouse.

The machine shop occupies the main portion of the building. When completed it will contain one 1200-lb. steam hammer, one 90-in. wheel lathe, one 42-in. car-wheel lathe, one 36-in. lathe, one 36x36-in. x 12-ft. planer, two 18-in. engine lathes, one 37-in. boring mill, one 37-ton press, one 28-in. drill press, one 600-ton wheel press, together with numerous small lathes, forges, slotters, radial

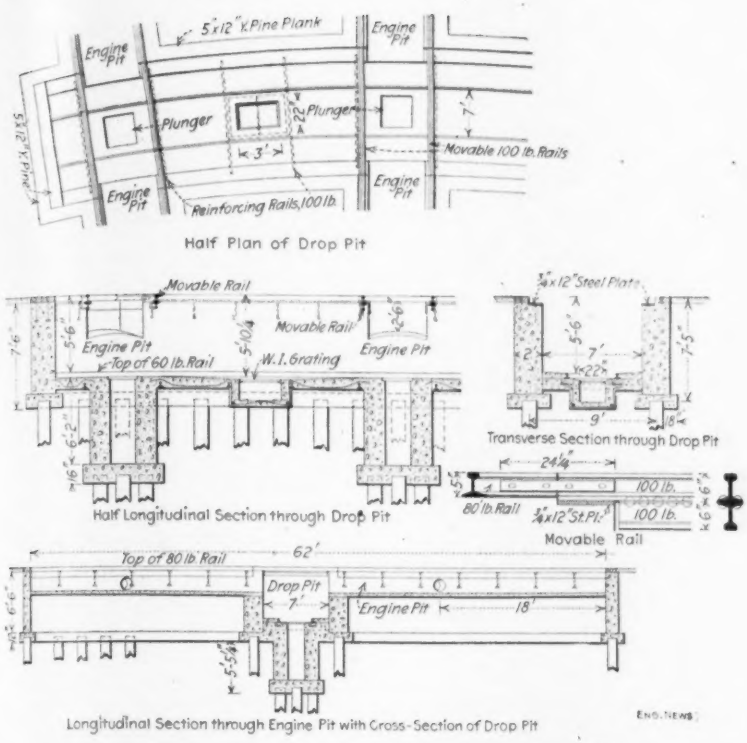


FIG. 6. DETAILS OF ENGINE PIT AND DROP PIT, ENGINE HOUSE

drills, double-head shapers, flange forges, boring and mortising machines, grinders, etc. A small tool room will be located in the southeast corner of the machine shop. An engine track from the roundhouse to the outer turntable passes through the machine shop; this track can be used in emergencies as an engine track to and from the roundhouse in case of derailment blocking the main entrance of the roundhouse.

The toilet and locker room is located on the east or river end of the building and occupies a space of 77 ft. 4 in. by 31 ft. 6 in. This space is divided into three rooms; a locker room, with 370 metal lockers; a wash room, containing 48 wash basins, and the toilet room, with 18 individual toilets. Six 24-in. ventilators, made of galvanized iron, are installed in the roof. The machine shop, toilet and locker part of the building will be heated by a hot-air blast system consisting of engine fan and heater, containing 1300 lin.ft. of 1-in. pipe, through which exhaust steam will be carried to heat the air.

OFFICE, STORE AND OIL-ROOM BUILDING

This building is 152 ft. 6 in. by 47 ft. wide. The office and storeroom part of the building is two stories high with an attic, while the oil room is only one story with a basement for the oil tanks. The building is built on concrete piers 16 ft. on center, supported by five piles under each pier. Spanning between the piers is a reinforced-concrete beam. The walls of the building are of brick, 12 in. thick, with pilasters in the storeroom 16 in. square and 16 ft. on centers. The floor of the oil room over the basement is supported by 12-in. I-beams about 7 ft. on centers, over which is a concrete slab 4 in. thick, reinforced with wire-cloth mesh. The roof is of wood covered with five-ply pitch and slag roofing. The east end of the building will be taken up for the offices of various foremen and an engineers' and firemen's waiting room, and the central part of the building will be occupied as a storeroom, while the second floor will be taken up by an instruction room. A locker room, with 306 metal lockers; a bunk room containing 18 double bunks; a toilet room, 17x17 ft., with 6 toilets and 9 wash basins, and a storage room. The west end of the building is occupied by the oil room, 30x47 ft., with oil tanks in the basement connected to oil pumps located in the storeroom. The building is to be heated by exhaust steam, which is to be piped from the power house.

CINDER PITS

Two cinder pits are located in the two inbound engine tracks which lead to the roundhouse. Each pit is 150 ft. long, 4 ft. 2 in. wide and 4 ft. deep. These are the ash pits referred to as being built on filled ground. The side and end walls of each pit are supported by a concrete slab 154 ft. 6 in. long, 8 ft. 8 in. wide and 2 ft. 4 in. thick, reinforced with 4-in. 60-lb. rails; the walls are built of concrete faced with firebrick. The floors of the pits are paved with granite blocks, seconds, grouted with portland cement. Protecting plates, 3/8 in. thick, bent to fit the top and inside face of the walls, are anchored by means of 3/4x8-in. bolts. These plates are bent to project 1 in. beyond the brickwork to protect it from clam-shell bucket. The cinders are removed by means of a clam-shell bucket operated on a four-motor overhead traveling gantry crane, with a span of 16 ft. c. to c. of runway rails. The crane is cantilevered each way sufficiently to give an effective travel of bucket of 8 ft. to center of ash pits, which are 32 ft. c. to c. Motors operate on a 440-volt, 60-cycle, three-phase line.

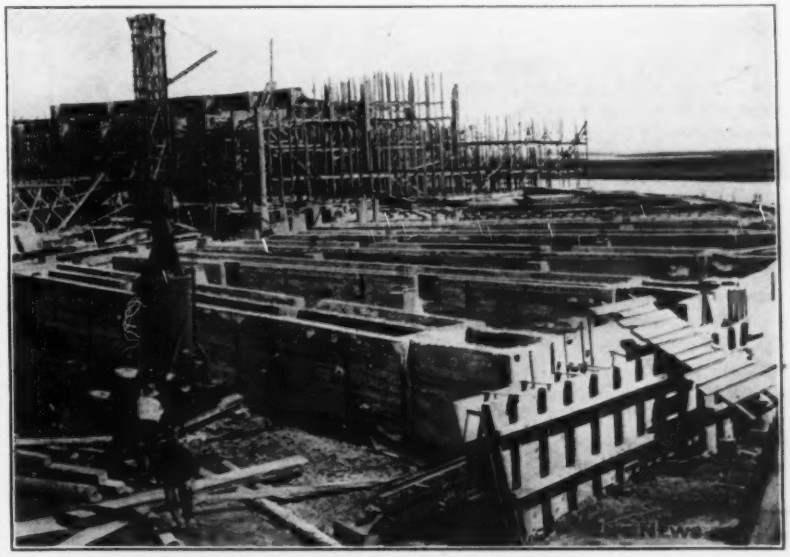


FIG. 7. VIEW OF ENGINE HOUSE IN COURSE OF CONSTRUCTION

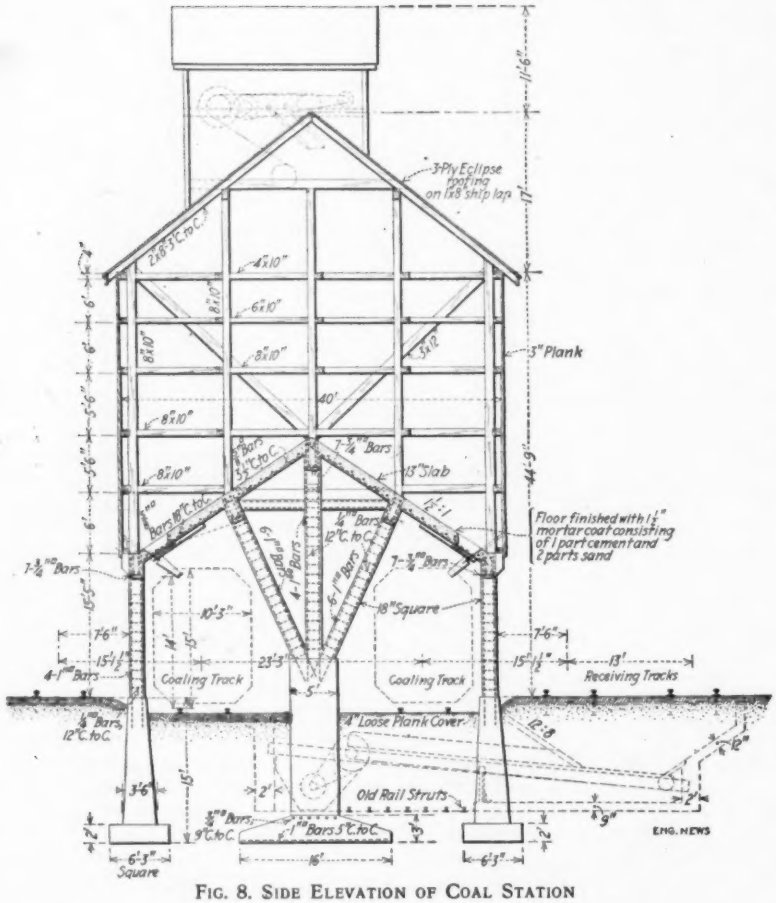


FIG. 8. SIDE ELEVATION OF COAL STATION

COALING STATION AND SAND DRIER

The locomotive-coaling station (Fig. 8) is of the elevated bunker type, extending across two inbound engine tracks. The structure is 58 ft. 7 in. long by 40 ft. 6 in. wide and is built of concrete up to and including the floor of bunker. The bunker has a storage capacity of 1500 net tons and is of the self-emptying type, the floor of which is sloped 1½ to 1, with counter hoppering constructed of hardwood between the coal gates and in corners. The structure is supported by three rows of columns. The outside columns are spaced 8 ft. 1 in. on center and are 18 in. square, reinforced with 4-ft. 1-in. square twisted rods placed in corners and hooped with ¼-in. square bar bands 12 in. on centers. The center supports located between the two engine tracks are 8 ft. 1 in. on centers, each support is composed of three separate columns resting on a concrete pier; the piers rest on a continuous reinforced-concrete footing extending the entire length of the structure. All beams are reinforced on the upper flange over supports to provide for the negative bending moments. The floor of bunker is a concrete slab. The walls above the floor are of wood sheathed with plank vertically on the outside of girts. Six coal gates of the guillotine type, equipped with steel aprons, will deliver coal from the bunker direct to tender of engine on either track. There are two receiving tracks for coal, underneath which is a receiving hopper 20 ft. long, 24 ft. wide and about 15 ft. deep. A feed loader conveys the coal through a tunnel under the engine tracks from the receiving hopper to the bucket-elevator boot, which is located at the center of the bunker between the two engine tracks. The elevator is built of V-pattern buckets, 24x30 in., made from ⅜-in. sheet steel; buckets are spaced 32-in. centers mounted on two strands of steel chains 16-in. pitch with reversable hardened bushings and rollers. The handling capacity of elevator is 130 net tons per hour, traveling at a speed of 100 ft. per min. Two chutes located at the top of the elevator properly distribute the coal to each half of the bunker. A 30-hp. motor located in the monitor of the bunker at the elevator discharge, drives the machinery.

A sand drier (Fig. 9) is located about 200 ft. east of the coaling station and consists of a one-story building 18x40 ft., built of wood with a concrete floor, in which are two sand-drying stoves and screens. After the sand is dried, it is then screened and empties into a receiving tank from which it is forced by compressed air through a 4-in. pipe to a dry-sand storage bin arranged at the east end of coal bunker. Two spouts feed the dry sand to the locomotive sand boxes.

ARTIFICIAL ILLUMINATION

All buildings and engine yard will be lighted by electricity. Pipe conduits are installed in the roof beams, walls, columns and floors of the various buildings.

WATER SUPPLY

A 6-in. connection has been made with the New Haven Water Co.'s main at the corner of Lyman and Welton Sts. This

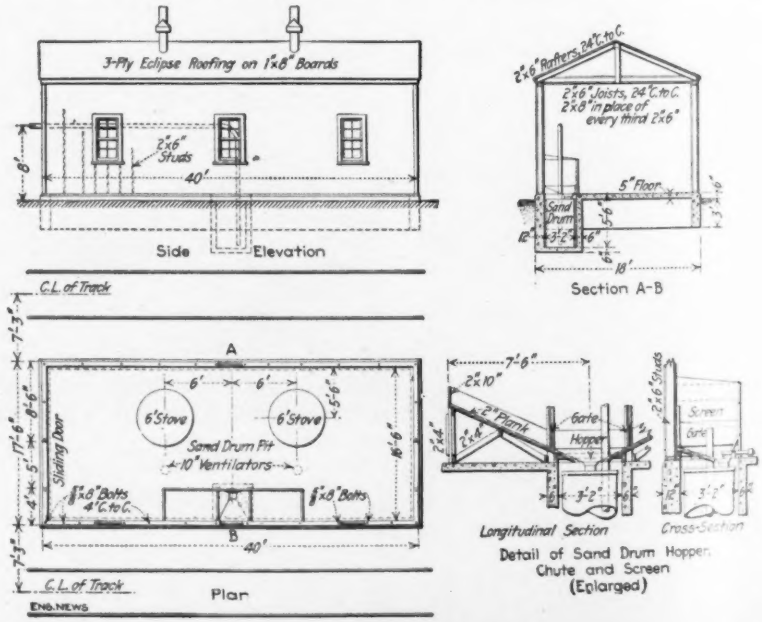


FIG. 9. DETAILS OF SAND DRYER

6-in. line passes under the freight tracks and ends at the power house. Connections are made with all buildings and at the ash pits and coal pocket. Fire hydrants are located at convenient points with connection for the city of New Haven standard 2½-in. hose couplings. A 4-in branch supplies the 55,400-gal. water tank. From this tank water is distributed to four 12-in. water cranes, two of which are located at the entrance to the engine yard; one about 60 ft. east of the coal pocket supplying two engine tracks and one east of the ash pits at a point where the engine tracks branch, one leading to the engine house and the other to the outer turntable.

The water tank (wooden staves) is located about 200 ft. west of the roundhouse on a reinforced-concrete support built of columns with a slab floor on top. Foundations are supported by piles 45 ft. long; the four columns under the center are 16 in. square and the eight small columns spaced evenly around the outer edge are pentagonal in shape, 12 in. on a side. The outside columns are rigidly connected by horizontal braces around the bottom and at the middle point. The outside and interior columns are also connected by horizontal braces; diagonals are used as lateral bracing for the interior columns. The floor of the support is 37 ft. above the ground, while the top of the tank is 56 ft. above the ground. A connection is made between the 6-in. line and the 14-in. supply from the water tank to the cranes; in case the tank should get out of order, it is possible to supply water to the cranes direct from the 6-in. line.

Contractor's Plant

All concrete in the engine house was mixed in a 1-cu.yd. mixer to which sand and stone were fed from bin by gravity and the concrete distributed to different sections of the work in a 30-cu.ft. car operated by an endless cable over a wood trestle about 20 ft. high, which was built from the elevator at the mixer over the center of the turntable to a similar elevator at the outside of the roundhouse at the inner circle. The elevators were equipped with automatic dumping buckets operated by hoisting engines. At several points along the trestle, chutes were arranged by means of which the concrete was let into the carryalls and thence placed into pits and foundations. The concrete for the columns, roof beams and slab was elevated to the roof, where it was placed in the forms, the work being carried on so that the columns, roof beams and slab of every two stalls was poured monolithically. By the above method, an average of 100 cu.yd. of concrete was placed in a day; at favorable points, 27 cu.yd. of concrete was placed in an hour. Steam for the contractor's plant was furnished by a 125-hp. marine boiler. The work on the auxiliary buildings was started in the fall of 1911 and the concrete and brickwork was carried on continually during the winter months. By means of steam coils, the sand and stone were kept free from frost, and special care was taken in order to maintain a temperature of about 65° in the mixed concrete. Owing to the small sections of the reinforced beams it was necessary to place canvas and salt meadow hay over them to prevent freezing and all steel reinforcement was cleaned and heated with steam before placing concrete in forms.

The Cedar Hill engine-house facilities were designed by the Engineering Department of the New York, New Haven & Hartford R.R.; E. H. McHenry, Vice-President; Edward Gagel, Chief Engineer; H. L. Ripley, Engineer of Construction; W. H. Moore, Engineer of Bridges, and the writer is in charge of the work.

Manufacturers' Standard Pipe Fittings

In Engineering News, July 18, 1912, we noted the proposed new standards for flanged pipe fittings framed jointly by the American Society of Mechanical Engineers and the National Association of Master Steam and Hot Water Fitters. When the new standards were formally presented it was stated that a factor of safety of 2 or less had been found in the flange bolts of pipe fittings commonly supplied compared with 16 to 20 from ordinary pipe-line pressure stresses.

The manufacturers of fittings have not generally agreed to the new dimensions proposed, but they have been stimulated to investigate the conditions which led to the promulgation of the new standards and they have admitted that changes in generally accepted practice were desirable in a number of cases. The manufacturers claim*, however, that the "1912 U. S. Standard" has provided a bolting for flanges all out of proportion to the necessities of present practice and they have formulated another set of designs for extra-heavy fittings known as the "Manufacturers' Standard." These have more moderate bolting.

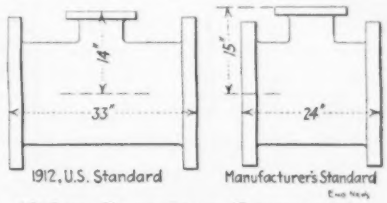
The manufacturers have conceded no changes in the ordinary flanged fittings except in a couple of cases where the number of bolts has been increased.

The "1912 U. S. Standard" provides a longer center-to-center face dimension, but this the manufacturers claim was not logical, or needed, and was secured merely by taking the average of several sets of published dimensions, some of which were out of date and not corresponding to goods now being made.

The reducing fittings of the "1912 U. S. Standard," it is claimed by the manufacturers' committee, have the same dimensions of run as have the straight fittings regardless of the reduction. The manufacturers regard this as out of proportion. A comparison between the "Manufacturers' Standard" and the "1912 U. S. Standard" is shown in the accumpanying figure which gives the dimensions for a 16x16-in. extra-heavy T according to both standards.

In the August *Journal* of the American Society of Mechanical Engineers is a discussion of the claims of the Manufacturers' Committee, and from this the following is extracted:

> In comparing the 1912 U. S. schedule of standard-weight flanges with the alternative submitted by the Sub-Committee of Manufacturers, in respect to diameter of bolt circle, number of bolts, diameter of bolt holes, we find they are identical, with the one exception that the U. S. Standard gives ¾-in. instead of ⅝-in. for diameter of bolt holes of 4-in. pipe.
>
> The standards of the Engineering Standard Committee of Great Britain and of the Verein Deutscher Ingenieure do not have sizes exactly corresponding to the



16x6-in. Extra-heavy T-fittings' Dimensions, According to the "Manufacturers" and "1912 U. S." Standards

> standard weight and extra heavy weight of the 1912 U. S. Standard, but have the most important dimensions the same for all pressures, making their piping on low pressures unnecessarily heavy and expensive, but without securing absolute safety for high pressures.
>
> For extra-heavy flanges, up to 9-in. inclusive, the 1912 U. S. Standard and the standard of most manufacturers are identical. Above 9-in. the U. S. Standard is somewhat larger than the present standards. Wherever there is a distinction between the 1912 U. S. and the proposed Manufacturers' Standard, the 1912 U. S. is invariably on a side of greater safety and strength and has the added feature of interchangeability where the proposed manufacturers' schedule has different face-to-face dimensions.
>
> In Germany there is reported in the public press dissatisfaction with existing standards as not being safe in the extra weights.
>
> The 1912 U. S. Standard has been in operation two months and has already been approved and adopted by the U. S. Navy, U. S. Bureau of Standards, Isthmian Canal Commission and is under consideration by other departments. Large concerns, such as the Interborough Rapid Transit Co., the New York Edison Co. and others who have had fittings made from their own patterns because there was no standard, have agreed to adopt and use this one.
>
> The committee of the American Society of Mechanical Engineers has decided after a most careful consideration not to re-open the subject.

*In a circular issued by the Committee of Manufacturers on Standardization of Fittings and Valves, W. H. Douglas, Sec., 30 Church St., New York City.

Railroad Appraisal and Taxation in New Jersey

By Charles Hansel*

At the Fifth Annual Conference on State and Local Taxation, held at Richmond, Va., last September, Allen Ripley Foote, President of the National Tax Association, offered a paper describing a short method of determining the valuation of railroad property for the purposes of taxation. Mr. Foote did not favor any of the methods pursued in those states which have determined value by a survey and appraisal of the physical property, coupled with a valuation of the nonphysical value, and stated that all such methods are impracticable.

The formula offered by Mr. Foote resolves itself into a tax of 2% on the gross earnings of all railroads which require 90% or more of the gross earnings to pay operating expenses. When a railroad is operated more economically and the percentage of cost of operation falls below 90%, then, "a differential of ⅓ of 1% computed on each 1% increase in the margin of difference between total revenue and total operating expenses in excess of 10%" is computed and added to the 2% on gross earnings.

Mr. Foote refers to the State of New Jersey, with Michigan and Wisconsin, as having adopted the *ad valorem* method, and says: "In each case the expense, the time required, and the inconclusive results have demonstrated the impracticability of this method."

There is nothing to warrant the statement that the system of valuation pursued in New Jersey is not entirely satisfactory. The results of the work in New Jersey show an increase of $98,000,000 over the assessment of 1910. This amount will probably be reduced somewhat on appeal, more especially on account of questions arising as to situs of personal property. The railroads have taken no appeal on the ground that the work was not conducted fairly and justly. On the contrary, the spokesman selected for the railroads to address the State Board of Assessors, at a public hearing called to give the railroad officials an opportunity to present their views on the method of determining the intangible value, said:

> I may say, also, the spirit of fairness, which it seems to me, now that I know something about Mr. Hansel's method, has characterized his investigation into this whole railroad situation for the last year or so. . . .
>
> Frankly, this method of franchise valuation seems to me, for the first time, a scientific one; and, properly carried out in its application, the fairest that has yet been suggested; and I notice that, since Mr. Hansel has put it into operation, it has been approved by our New York Court of Appeals, in this recent Manhattan Railroad case.

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Mr. Foote refers to the New Jersey law as being the *ad valorem* taxation of railroads. If it is understood that the phrase *ad valorem* means "according to value," he is correct. If, however, he means according to value of the physical elements alone, i.e., real estate and tangible personal property, he is not correct.

Like Ohio, the State of New Jersey requires all property to be taxed by a uniform method. The courts have held that this uniform rule is to be applied to property of the same class, and differentiates between general property and the property of railroads and public utilities. The railroad act of New Jersey is based upon the "true value" of the property, or *ad valorem*, according to value. This does not mean that the sum of the price value, or the bargain and sale value, of the thousands of parts shall be summed up into a total which will be declared to be the value.

The law has provided an equalizer or differential of a flexible character in declaring that, after the real estate and the tangible personal property are appraised, then, there shall be an appraisal of "the remaining property, including the franchise"; and the sum of the value of the physical elements plus the value of "the remaining property, including the franchise," will represent the "true value."

Justice Brewer, of the Supreme Court of the United States, says: "Now, it is a cardinal rule, which should never be forgotten, that whatever property is worth for the purpose of income and sale it is also worth for the purpose of taxation." Many of the more advanced students of economics concede that there may be a wide difference between taxable and investment values; and, therefore, that the valuation of physical property may be undertaken for any one of a number of different purposes.

If we were to attempt appraisal by the formula proposed by Mr. Foote, the value of a railroad whose operating expenses are 90% or more of its gross earnings would be determined by the gross earnings only. The writer is unable to understand on what theory the gross earnings of a railroad company can be held to represent the "true value" of that railroad property. The operating expenses, in some cases, are more than the gross earnings. In the case of roads whose operating expenses are less than 90% of the gross earnings, Mr. Foote supplements the gross earnings by a differential based on the net earnings. It does not appear that the results so obtained in any wise represent a tax based upon the "true value" of the property.

According to Mr. Foote's formula, "operating revenue within the state is obtained by dividing the total operating revenue of the system by the total miles of single track owned or operated and multiplying the quotient by the number of miles within the state."

The definition of "single track," as used in the foregoing, means miles of route; and, in the discussion at Richmond, the writer contended that miles of route in nowise indicated the allocation of the proper proportion of earnings or value of the parts of an interstate railroad in different states, and that the best available factor for allocating the earnings and the value of interstate railroads into states and civil divisions of states was the all-track basis. It is this basis which has been used in the State of New Jersey in the revaluation of railroads and canals under the direction of the writer.

Thirty representatives of the six New England states lately met in Boston and decided that the all-track mileage should be the basis used for allocating the property of interstate railroads among the several states.

As an illustration of what injustice would be worked by the use of the miles-of-route basis in New Jersey, take the following statement of railroad mileage in New Jersey:

TRACK MILEAGE IN NEW JERSEY, 1911

Miles of route	2369.075	
Miles of second track	897.179	
Miles of third track	156.915	
Miles of fourth track	140.278	
Miles of running track		3563.447
Miles of sidings	1885.837	
Total miles of all tracks		5449.284
Percentage of miles of route to total miles of all tracks		43.47
Percentage of miles of sidings to total miles of all tracks		34.60
Percentage of miles of 2nd track to miles of all route		37.87
Percentage of miles of 3rd track to miles of all route		6.62
Percentage of miles of 4th track to miles of all route		5.92

It will be observed that, whereas the miles-of-route or single-track-miles is 2369, the total of all tracks is 5449 miles and that the miles-of-route is but 43.5% of the total miles of track within the state.

The injustice of using miles-of-route for the allocation of property into states or minor civil divisions is further illustrated in Jersey City. The total appraised value of the railroad property in New Jersey, exclusive of personal property and franchise, is $206,740,000. Of this total, $59,631,000—or more than 28% of the total value of real estate in the State of New Jersey—is found in Jersey City. The total miles-of-route in the State of New Jersey, as before mentioned, is 2369; the total miles-of-route in Jersey City, of all railroads, is 43 miles. If the allocation of property were made on the basis of miles-of-route, as suggested by Mr. Foote, then Jersey City would receive less than 2% of the total value of all the railroad property in the state, instead of 28%, which is the actual apportionment.

If, on the other hand, the allocation were made on the basis of all-track miles, Jersey City would receive 10% as against 2% on the basis of miles-of-route, the miles-of-route in Jersey City being 43, and the miles-of-all-track in Jersey City 533. It will be seen, therefore, that, in the case of tide-water terminals, and at points where the values of property are

high, the apportionment of value cannot be made on any basis of track miles, or by any other method than the valuation of the property situated in each particular state or minor civil division.

Therefore, it is absolutely necessary to a reasonably accurate determination of value to ascertain the value of the physical elements having a permanent situs in each particular state or minor civil division.

Since the miles-of-all-track represent more nearly than any other obtainable factor the capacity to do business and to earn money, we think that all rolling equipment and revenue can be fairly apportioned to states and minor civil divisions on the basis of all-track miles.

It must be apparent, however, that miles-of-route in nowise indicate the capacity to do business or the extent of the property; as, under such a method of distribution, single-track would be given as great a value as four or more running-tracks; and no account whatever would be taken of the vast investment in terminal property in case miles-of-route were taken as a basis.

The survey and valuation of the physical elements of the railroads of New Jersey have been completed and the results are now in the hands of the State of New Jersey, carefully tabulated and comprising 114 volumes, which will constitute the basis of a permanent record; and it is comparatively easy for the state to keep the record up to date. The organization of the State Board of Assessors is such that all additions, or deductions from, physical property will be accurately ascertained each year. Consequently, the expenditure which has been made in the actual survey of the railroads and canals of New Jersey is entirely justified by the result.

The ascertainment of "true value" is certainly as important to the railroad companies as to the state and, if the tax rate that the state levies on the value so obtained puts too great a burden upon the railroads, then the only question to consider is the rate of taxation, and not the value of the property. The general property of the state should, of course, bear its full share of the burden of taxation; but the only large item of value that is found in common with railroad and general property is the item of land; and there is much difference of opinion as to the proper method of valuing the land within the right-of-way of a railroad as well as the additional land needed for terminals, station grounds and yards.

The State of New Jersey levies a tax on all the railroad property contained within a strip not exceeding 100 ft. in width, called "main stem," together with the track and structures thereon, the locomotives, cars and other personal property, and the "value of the remaining property, including the franchise," is assessed at the average tax rate of the state, which rate is determined by adding together all of the ratables of all of the counties and dividing that sum by the total assessment on all the ratables in all the counties. The rate so obtained for the year 1911 was 1.896.

All of the land and real estate outside of the one-hundred-foot strip is assessed at the local rate, although all of the railroad property used for railroad purposes within the state is appraised by the State Board of Assessors.

There seems to be no particular justification in using the average state tax rate as the rate to apply on railroad property and, since the railroad companies have no voice in the appraisal of the general property, nor in the administration of the affairs of the municipalities; and, since the tax collected on main-stem property goes to the school fund of the various municipalities and to the support of the state, it would seem proper to use a tax rate on the railroad property of main stem based upon the needs of the state rather than upon the average needs of the communities, some of which are not traversed by the railroads; and, since the railroads are assessed as a class separately from general property, it would appear that the question of the tax rate established by assessment of general property should have no particular bearing on the tax rate which should be assessed on railroad property.

The railroads of New Jersey are paying a greater tax per mile of route than is paid in any other state. The reasons for this are:

First—That there is in New Jersey a greater mileage of running tracks, sidings and terminal tracks as compared with miles of route than in any other state.

Second—The railroad property of New Jersey is appraised at "true value"; which has been interpreted to mean the value of the land used for railroad purposes plus the cost of reproducing the permanent way, buildings and structures; and the equipment and tangible personal property (less depreciation) plus the "value of the remaining property, including the franchise."

Third—The tax rate levied on "main stem," which "includes the road bed (and land) not exceeding 100 ft. in width, with its rails and sleepers and all structures erected thereon and used in connection therewith, not including, however, any passenger or freight buildings erected thereon," all equipment and tangible personal property and the "value of the remaining property, including the franchise," is the average of the tax rates levied on the general property throughout the state.

Fourth—The assessment of general property throughout the state is not appraised at true value and the appraisal is made by some 525 assessors elected or appointed. The work of the assessors is under the general direction of the County Boards of Taxation. The Board of Equalization of Taxes is a state board with power to equalize the assessments. Neither the County Board of Taxation nor the assessors are compensated on the basis of devoting their entire time to the work, and comparatively few assessors are equipped with maps, or any definite description of the property they appraise.

There is no system of uniform instructions, or value data, to guide the assessors. In consequence, the methods of determining value are in nowise coördinated; nor has the County Tax Board power to dismiss an assessor who is incompetent.

Fifth—The average tax rate is raised or lowered by the extravagant or economic administration of the minor civil divisions—termed "taxing districts"—as well as by the assessors' interpretation of the "true value" and their knowledge of costs of construction, depreciation, and normal values of land. It is likely that the 525 assessors, selected as they are and never meeting in conference, do not approach uniformity in methods.

It is not likely that the bankers who control the railroad systems of New Jersey would care to say that the appraisement of the railroad properties of New Jersey by the State Board of Assessors, for 1911, based on valuation furnished by the writer, was greater than the "true value" of the properties. And, if the taxes paid by the railroads of New Jersey are greater in comparison with other states, or greater in comparison with taxes paid on general property in the State of New Jersey, I think the remedy lies either in appraising general property and railroad property by the same "yard stick" (or, at least, so far as property not included in the "main stem" of railroads is concerned) or in fixing the rate to be applied to main-stem property entirely independent of the assessment of general property.

The writer is firmly of the opinion that the present valuation of railroad property in New Jersey is below, rather than above, the "true value" of the several properties; and, if it is demonstrated that the taxes paid by railroad companies in this state are excessive, the remedy lies in reducing the rate of taxation, and *not in reducing the valuation* placed upon the properties.

The State Board of Assessors appraise the railroad and canal property of the state; the Board of Equalization of Taxes appraise the general property of the state, and the Taxing Districts fix the rate to be levied on the general property within the taxing districts.

The State Board of Assessors pursue their work of appraisal entirely independently of any other taxing authority of the state; and, yet, when they apply a tax rate upon a property they appraise, they are required to accept and apply the

average tax rate of the state to the property in the main stem; which is some 73% of the total appraisement. The State Board of Assessors are thus compelled to fix the rate of assessment on the property they appraise which is determined by appraisal of general property by hundreds of independent assessors who are not under the authority of the State Board of Assessors; and, added to this anomaly, the governing body of the taxing districts fix the rate on the assessment of these independent assessors according to their views of the needs of the community.

The purpose of the foregoing analysis of the method of determining the taxes to be paid by the railroads is to direct attention to the method of assessment as compared with the method of appraisal of railroad property.

The method of *appraising* the value of railroad property of New Jersey as conducted by the State Board of Assessors is, in the opinion of the writer, a scientific method. The method of *assessing* this property is open to a variety of opinions.

It is manifest that two important problems are joined in the determination of the important result, i.e., the appraisal and the assessment. The first problem has been solved by the State Board of Assessors. The second problem must be answered by the Legislature of the state.

In a pamphlet entitled "Vagaries of Railroad Taxation," the writer attempts to point out the necessity of coöperation among the several states, as follows:

"There must be some method of railway taxation which is reasonably correct and understandable. It is not likely, however, that satisfactory progress will be made toward uniformity or practicability unless the matter is made the particular business of the railways, working in conjunction with representatives of the several states.

"The state legislators seeking to draft a bill for the taxation of railroads are not in a position to try out their theories by actual application. They are in the same position as an engineer or an architect who is called upon to draw plans and specifications and to determine costs without knowing the characteristics or the physical and elemental value of the various materials and members he is required to employ. Consequently, the legislators, be they ever so well qualified in mind and in integrity of purpose, must of necessity fail to draft a bill based on a comprehensive understanding of its meanings and the results to be obtained through its enforcement.

"The scope and meaning of the words 'True Value' and 'Franchise Value' are illusive and fugitive. The definitions of these terms change with their application and can only become fixed and understandable when they are nailed fast by legal determination in the detailed specifications of some particular law. Then, so far as that law is concerned, their meaning and scope are defined, limited and fixed."

The taxes paid by railways are among the largest items of fixed charges, and are increasing at an appalling rate. In 1900, the railroads paid $47,475,433 in taxes; which, in the next ten years, increased to $99,423,112, an increase of 109.42%.

During this same period, the average receipts per passenger-mile *decreased* 3¼%, while the ratio of operating expense to operating revenue *increased* 2.52%.

The average amount of taxes paid per mile of route increased from $254.78, in 1900, to $431, in 1910. This increase was largely in states where the burden of taxation was very heavy, as is illustrated by the following:

	1900	1910
Connecticut taxes per mile	$965	$1,867
Massachusetts taxes per mile	1,411	1,484
New Jersey taxes per mile	722	2,290
Rhode Island taxes per mile	843	1,302
District of Columbia taxes per mile	717	1,562

The statistics for 1911 are not available and, undoubtedly, the comparisons when made will show a considerable increase over 1910 in ratio of operating expenses to operating revenue, as well as in taxes paid; while, on the other hand, the net revenue per passenger- and per ton-mile will have decreased.

It is popular for the general public, as well as many railway officials, to condemn railroad taxation as now applied in the several states. I think we can justly write above the opinions of the many, the inscription

Damnant quod non intelligunt.

I am told that it has been the experience of railroad officials, that every effort on their part to secure uniform and just taxation has failed because of certain politicians seeking to acquire political capital by increasing the taxes to be paid by the railroads regardless of the fairness of the method. While this may have been true in the past, I do not think that it can be said with equal force today.

The whole tax question is so profound as to stagger the mind, and the railroads should not expect justice in the supreme court of public opinion until that court is furnished an opportunity to judge the facts, for the people are not blind to justice though Justice be blind."

A New Mine-explosion Experiment station is to be established by the British Government, at Eskmeals, on the Cumberland coast. In 1910, the Mining Association of Great Britain, which had been carrying on the experiments at the Altofts colliery, in Normanton, urged that future study should be carried on at public expense, and offered to lend the plant and apparatus which had been accumulated. This was finally agreed to. The Altofts side being no longer available, the first thing was to find a new one which should be at equal distances from the coal fields of England, Wales and Scotland, and have good railway connections.

In the new location all the plant, with the exception of the laboratory, stands in a hollow where it is completely hidden by surrounding sand hills. There will be three tubes or galleries in which coal-dust explosions can be made. The largest will be 7 ft. 6 in. in diameter and 800 ft. long. It is made of discarded boilers and is the one employed at Altofts. One end points seaward and there is room for increasing its length to 700 yd. in a straight line. It rests on sleepers laid on the shingle and care has been taken to make the joints between the different sections gas tight by means of asbestos rope, a precaution not observed at Altofts. At the eastern end an arm turns at right angles and from this again a second arm runs parallel to the main tube and leads to a fan-house. A smaller gallery is made of 3-ft. flue-pipes and is 400 ft. long. It is supported on concrete pillars alongside the main gallery and can be joined to it at each end by curved tubes. It can be divided up into compartments for containing gas mixtures so that a gas explosion started in it can be used to initiate the coal-dust explosion in the larger gallery. The firing stations in connection with these two tubes stand on a sand hill to the north and consist of two boiler shells of ½-in. plate, placed end to end, and having a total length of 60 ft. From this station are controlled the recording instruments mounted in a series of huts between the two galleries. Records will be taken of pressure and velocity, and in each hut is an apparatus which will photograph an explosion through a slit in the tube covered with thick glass. Near the sea there will be an observation station having a view of the mouth of the tube. A gas holder supplies the larger and smaller galleries. Still farther to the north there is a third tube 1 ft. in diameter and 150 ft. long. In this it is expected that preliminary experiments may be run here to obtain warning of the conditions which have to be met in making the larger tests. In the power house south of the main tube are two semi-portable 25-hp. engines driving a 110- and a 220-volt generator, supplying a storage battery. Another house contains a stone-crushing plant and another the gas generators. There is also a carpenter shop and mess room for the staff. Most of the buildings are of brick plastered with portland-cement and waterproofed. Their roofs are of slate. While they are grouped chiefly toward the firing end of the main gallery where bursting is not likely to occur, yet for extra protection strong barriers of sleepers, with sand between, will be erected. A 20-in. light railway connects the experimental station with the laboratory, which stands 350 yd. eastward on the other side of the sand hills. This last building has four large rooms and adjoining it is a house occupied by the chief chemist. One room in the laboratory is used as a store, another as a machine shop, while the other two are equipped with a complete set of apparatus for physical and chemical experiments in connection with gas analysis and the phenomena of explosion. Water, gas and electricity are laid in from a nearby town. (From the London Times, Engineering Supplement, Aug. 3, 1912).

A Hydrogen Pipe Line has been built in Germany, to carry hydrogen from a chemical works to the dirigible-airship station, near Frankfort. The pipe line is about three miles long, and is operated under a pressure of about 40 in. of water. Nearly the whole of the line is welded, couplings being used at long intervals only.

A Water Cooled Blast Furnace

A blast furnace with a comparatively thin lining, cooled by a film of water, in place of the usual solid brick lining 2 to 5 ft. thick, has been put into successful operation at Detroit, Mich. The results obtained show a superiority in regularity of operation and uniformity of product over those with the same furnace thick lined. The cost and time for reconstructing from thick to thin lining is given.

The blast furnace, as ordinarily used for the manufacture of pig iron, is merely a cylindrical steel shell lined throughout with firebrick. It is erected vertically, and the ore, fuel and flux are charged continuously into the top of the furnace. Near the lower end, blasts of air are admitted through the tuyeres. The combustion takes place principally near the lower part of the furnace and the gases produced pass off at the top, while the molten iron extracted from the ore is allowed to accumulate at the bottom and is finally drawn off through the tapping hole.

The furnace structure has three main divisions: the hearth or crucible at the bottom in which the molten metal collects; the bosh, which is the portion in the form of an inverted frustum of a cone immediately above the hearth; and the inwalls, constituting the entire upper part of the furnace above the bosh.

The hearth is usually cylindrical and contains the tapping hole, the cinder notch through which the slag is drawn off and the tuyeres, which are symmetrically placed around its upper circumferences a few inches above the level of the cinder notch. The blast enters the tuyeres from the bustle pipe, which is of cylindrical sheet steel lined with firebrick and encircles the furnace at a height of about 10 or 15 ft. above the floor.

The bosh as a whole is the melting zone. It has no steel shell outside of its brickwork, but is built up to the desired line and is then supported by a number of heavy steel bands completely encircling the different courses of brick. In the brick lining of the bosh, which is 27 in. or more in thickness, are inserted a number of bronze or copper cooling plates through which water is circulated. Each cooling plate is separately supplied with water so that any one can be removed in case renewal becomes necessary.

The inwalls, comprising the upper portion of the furnace, are supported upon the mantle. This is a circular ring built up of heavy steel plates and angles, which supports ordinarily not only the entire weight of the furnace shell itself, but the immense mass of brick lining as well. The mantle is supported upon a series of columns, either of cast iron or structural steel. This construction allows the entire hearth and bosh of the furnace to be torn down if necessary without disturbing any of the work above the mantle. The inwall portion of the furnace consists of a brick lining from 27 in. to even as much as 60 in. thick at the mantle and tapering from this point to a somewhat lesser thickness toward the top of the furnace. This entire portion of the furnace is surrounded by a riveted-steel shell. The diameter of the inwall portion is made somewhat smaller at the upper than at the lower end to allow greater freedom of movement for the descending charge.

The inwall portion of blast furnaces is the one which has given the most trouble. Deterioration of its brick lining under the severe conditions of modern driving is very rapid and the result is an increase in the internal diameter of the furnace at some points and occasionally the formation of a sort of shelf extending entirely around the inside of the furnace. Such depressions or shelves tend to retard the flow of the stock in its downward passage, sometimes even causing the formation of an arch with a cavity beneath it. With the breaking down of the arch there is a rapid transfer of materials toward the bottom of the furnace, and the iron produced under such conditions is very likely to be of a variable analysis.

It has become common practice to provide cooling plates, similar to those in the bosh, which are embedded in the inwalls of the furnace above the mantle. This practice has been recently extending, with the tendency to carry the plates higher and higher above the mantle ring. The coolers are usually installed in horizontal rows with a vertical spacing of from 2 to 4 ft. between rows. In a measure they serve to protect the brick lining from cutting out, but the cooling effect obtained is not uniform, with the result that the interior surface of the inwall lining may become corrugated, giving rise to an irregular passage of the stock through the furnace, though not to the same extent as if no protective cooling were provided.

The most recent development is the use of furnaces having inwalls with relatively thin linings, cooled throughout by a sheet or jacket of water. One of the earliest installations of this sort was a furnace constructed by Burgers at the Gelsenkerchen Works in Germany, in 1898, and the first installation of the sort in this country was made under the direction of James Scott, in 1908, at the Isabella Furnaces of the Carnegie Steel Co. Other noteworthy thin-lined furnace installations are those of the Illinois Steel Co., constructed and placed in operation early in 1909, and of the Tennessee Coal, Iron & Railroad Co., which was placed in operation during 1911. One of the most recent installations of this sort is that of the Detroit Iron & Steel Co.

The Detroit Furnace

Two general systems of cooling have been used in connection with thin-lined furnaces, one in which the cooling water circulates in troughs riveted externally to the steel-plate furnace shell, and the other in which the cooling is effected by means of circular spray pipes extending entirely around the stack and located at such intervals as to maintain a continuous film of water over the entire shell. The former method is subject to the objection that the cooling water is applied to the shell under some external head which necessitates water-tight joints in the shell construction, for any water admitted to the interior of the furnace would immediately affect its operations and have a destructive effect on the firebrick lining. For this reason, among others, the circular-spray system was adopted for the Detroit Iron & Steel Co.'s furnace.

Early in 1911, this company found it necessary to completely reline their "A" furnace. The stack was originally built in 1902 and has been in continuous operation since that time with the exception of short intervals. The shell had become considerably warped or buckled, with the result that the entire shell construction was out of plumb. It was considered necessary, therefore, to provide a new shell if the furnace was to be put into first-class condition. It was decided, however, to reconstruct the furnace with a thin-walled water-cooled construction.

The original furnace shell was composed of nine rings, the top and bottom ones being $\frac{5}{8}$ in., and the seven intermediate rings $\frac{1}{2}$ in. and $\frac{3}{8}$ in. in thickness. In spite of the warping or buckling, it retained enough structural strength to carry the load of the top structure comprising the charging apparatus, etc. It was accordingly decided to retain the old outer shell for this purpose and to build up inside of it a new thin brick lining with a steel shell of its own.

A sectional view of the reconstructed furnace is shown in Fig. 1. The inner shell is of $\frac{1}{4}$-in. steel plate throughout and is supported on an inner mantle ring carried on structural brackets attached to the original mantle columns, which were of very substantial construction and in

excellent condition. Three angle-iron rings are attached to the inner surface of the inner shell at different elevations to give support to the brick lining.

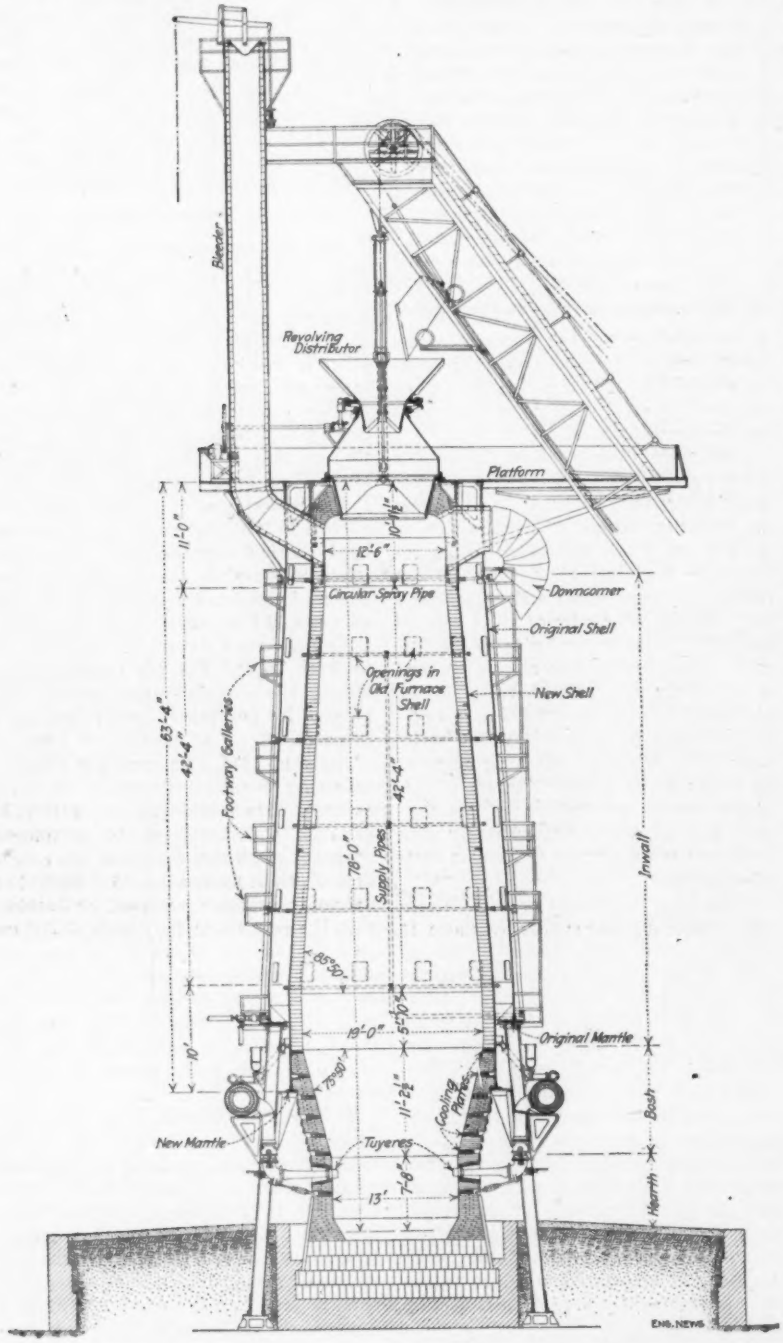


FIG. 1. SECTIONAL ELEVATION OF THE WATER-COOLED BLAST FURNACE OF THE DETROIT IRON & STEEL CO.

At the upper end of the shell of the furnace, cast-steel brackets were originally attached to the inside of the shell for the support of the platform. These brackets were retained in their original position, but their ends were cut off to give room for the erection of the new inner-shell top ring, and short lengths of angle iron were fastened across the cut-off end of these brackets as shown in Fig. 1. These angles are not attached to the inner shell, in fact a clearance of about ¼ in. is left between the top ring of this shell and the inner flange of the angle. These pieces of angle iron are supposed to bear against the inner shell, if necessary, and maintain the relative alignment of the two shells.

The entire inwall lining in the reconstructed furnace is 12 in. thick and composed of special hard-burned refractories adapted to the purpose. The overall height of the furnace is the same as in the original installation, but owing to the difference in thickness of the brick lining, it was found possible to make the hearth, bosh and stock line diameters 12 in. larger than those of the old furnace.

It should be noted that with the form of construction described, the inner and outer shells are left free for independent vertical movements due to expansion and contraction, and the outer shell, which is not subject to great changes in temperature serves to hold the inner shell permanently in position at the upper end and prevents the hopper and top from becoming eccentric with respect to the lower end of the furnace.

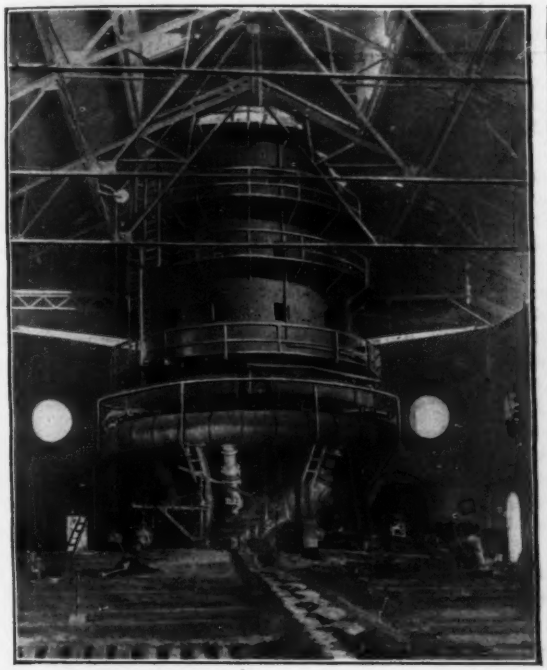
In order to carry out this freedom of movement of the inner and outer shells, it was necessary to attach the downcomers (of which there are three) and the two bleeders to the inner shell only. It should be explained perhaps that the downcomers are firebrick-lined pipes, which lead from openings in the top of the furnace to the dust catcher and serve to carry off the gas and products of combustion from the upper end of the furnace. After removal of the flue dust in the dust catcher, the gas drawn off through the downcomers is utilized as fuel. The bleeders are relatively short vertical pipes opening into the top of the furnace. They are closed with a valve at the upper end and are arranged to allow the escape of gas into the air at any time when this may become necessary.

In reconstructing the Detroit furnace, the downcomers were first connected to the inner shell by means of plate-work rings and were then cut free from the outer shell so as to allow the free expansion of the inner shell. The bleeders were attached directly to the inner shell and pass through openings in the outer shell. Most of their weight, however, is carried by brackets attached to the outer shell.

COOLING SYSTEM—The spray system of cooling is used. As shown in Fig. 1, there are six circular spray pipes surrounding the inner shell of the furnace. These pipes have spray orifices, ⅛ in. in diameter, spaced 6 in. c. to c., and are connected to four vertical supply pipes, arranged to give the most uniform pressure possible at the spray orifices. Valves are provided in the connections to the supply pipe to permit any necessary regulation of the flow of water. In this way a film of water is maintained over the entire surface of the inner shell. The thickness of the film is increased by each circular spray as the water passes downward, giving the greatest cooling effect at the lower part of the inwall

where the heat is greatest. A trough is attached between the two shells just above the upper mantle ring, in which the cooling water collects. Discharge openings from this trough are provided which connect to the sewer system.

Besides acting as a support for the charging platform and top structure, the outer shell of the furnace serves perfectly as a windshield for the water spray, making it certain that the film of water will be continuous over the whole surface of the inner shell. Six galleries or walkways are bracketed to the outside of the outer shell at the levels of the six



FIGS. 2 AND 3. DETROIT BLAST FURNACE AS RECONSTRUCTED WITH WATER-COOLED THIN LINING

circular spray pipes. Workmen, standing on the galleries, can inspect or reach the spray pipes, if necessary, through rectangular openings cut through the outer shell. These openings, of which there are twelve at each gallery level, can be seen in Figs. 2 and 3.

OPERATING RESULTS—The reconstructed furnace was blown in early in December, 1911, and has given since that time exceptionally good results in operation. We are informed by Arthur G. McKee, of Cleveland, Ohio, who had charge of the reconstruction work, that the tonnage has been increased about 24% with the reconstructed furnace compared with the average tonnage made by the original installation during the seven years previous. This increase he ascribes in part to the increased diameter of the stack but also to the remarkable regularity of operation resulting from the water cooling.

The fuel used in this furnace has always been byproduct coke, both in the old and new installations. When operated as a thick-lined furnace, it was impossible to carry a burden-to-fuel ratio of more than 1.7, but with the new construction this has been increased to over 2. The furnace is operated on merchant iron and has encountered the necessity of frequent change of product as is usual in furnaces making iron for the open market. The quality of the iron has been remarkably uniform, no difficulty being encountered in maintaining the sulphur contents under 0.04 with a range of silicon of from 0.75% to 3%. It is stated further that the furnace responds with great promptness to any changes of burden.

COST OF RECONSTRUCTION—One of the chief objections to the rebuilding of blast furnaces to change them to the thin-lined construction has been the high first cost. This was due to the fact that with a thin lining it became necessary to provide a separate support other than the furnace shell for the skip bridge, top structure and platform, as well as for the inspection galleries outside of the shell. This supporting structure was usually made in the form of steel columns resting on the mantle ring and extending from there to the top platform. Mr. McKee estimates the cost of reconstructing a furnace by the method applied to the Detroit furnace as described at approximately $30,000 to $32,000—not materially more than is required for the relining of a thick-lined furnace. The amount given is for a furnace 20x80 ft. in dimensions. This cost covers the steel work, including the inner shell with its mantle and supporting columns, the galleries and all necessary alterations to the existing outer shell, connections of existing bleeders and downcomers, spray piping, brickwork and other incidental alterations. It is here assumed that the mantle columns are reasonably adapted to the support of the inner shell and that the outer or existing shell has sufficient strength to adequately support the load which it has previously carried without reinforcement.

The time necessary for converting a furnace of this size to a thin-lined installation, assuming that drawings are prepared and material and construction contracts placed before going out of blast, should be approximately nine weeks and should not exceed twelve weeks, unless unusual construction difficulties are encountered.

Reconstruction along the lines described provides to all intents and purposes a new furnace stack, the useful life of which should fully equal the original installation. Relining can be accomplished over a long period of operation with a saving of from one-half to two-thirds of the corresponding cost for a thick-lined furnace and with a saving in time.

The reconstruction of the Detroit Iron & Steel Co.'s furnace was carried out under the direction of Mr. McKee under patents issued to M. McMurray, manager of furnaces for the M. A. Hanna Co., of Cleveland, Ohio.

Sewage Purification at Reading, Penn.

By E. Sherman Chase*

The first municipal sprinkling filter for the purification of sewage in America went into operation at Reading, Penn., in January, 1908. This system has been in constant service since and its success has led to its adoption in many other cities of the United States. The sewage at Reading is treated by a fine mesh screen, settling tank, sprinkling filters and final sedimentation basins. The screen has a finer mesh than was ever used before and although the cost for its operation and maintenance is high, it has done efficient work. The settling tank was designed in the days of the septic tank but has been operated for plain sedimentation as it has been found that fresh, non-septic sewage is most desirable for subsequent treatment by sprinkling filters. These filters have been highly efficient in obtaining a uniformly non-putrescible effluent, well oxidized and with a bacterial efficiency of 80 to 90 per cent. The self-cleansing property of sprinkling filters has been markedly shown and with a non-septic influent the freedom from offensive odors has been noteworthy.

*Chemist in Charge of Sewage Works, Reading, Penn.

The present system of sewage purification at Reading, Penn., has been in operation since January, 1908. It consists of preliminary screening, sedimentation, and treatment by sprinkling filters, followed by final sedimentation. The system was designed by Messrs. Hering & Fuller, of New York, and up to September, 1911, was operated under contract by O. M. Weand, of Reading. Since the end of the contract, the operation has been carried on by the city.

At the present time there are 90 miles of separate house sewers in the city with 6912 house connections. The exact number of people contributing to the system is difficult to estimate exactly, but cannot be far from 40,000, while the total population is approximately 100,000. There are in all 24,458 buildings in the city and so only 28% contribute to the system. As most of the factories and places of business are connected, a great many people who live in houses which are not connected have access to the sewers at least part of the time. The number of connections increased from 275 in 1896 to 1298 in 1900, 6062 in 1910 and 6912 in 1911.

The sanitary sewage flow is received at one point in the southern part of the city where a pumping station is located for delivering the sewage to the purification works. The pumping station is equipped with three boilers rated at 60 hp. each and one boiler rated at 150 hp. The pumping is done by two horizontal, duplex, compound, condensing, plunger pumps, rated at 5,000,000 gal. each, but it is doubtful if the two can deliver more than 7,000,000 gal. daily.

PRELIMINARY TREATMENT OF SEWAGE BEFORE PUMPING—The sewage from the main trunk line empties into either one of two receiving wells 20 ft. in diameter, the bottom of these wells being 8 ft. below the invert of the sewer. To a certain extent these wells act as grit chambers; but as sewage is drawn into the suction pipes from the pumps only 18 in. above the bottom of the wells, the amount of deposition that can take place is but slight. Heavy sand collects in these wells to the level of the suction pipes, there being no chance to clean one well without putting both out of service which would necessitate shutting down the plant. That a large amount of sand might have been collected in suitably arranged grit chambers is shown by the fact that the large settling tank holds at present about 150 cu.yd. of sand in the first compartment, which has not been cleaned in the four years of operation. This sand gets into the sewer system through perforated manhole covers, especially in streets where storm-water sewers are lacking. The pumping of this sand has had a very bad effect on the condition of the pumps and accounts for their present poor service.

CHARACTER AND AMOUNT OF SEWAGE—The sewage received at the pumping station varies a great deal both in its rate of flow and in its chemical and bacterial characteristics, according to the time of year and hour of the day. Aside from purely domestic wastes the sewage contains the wastes from numerous manufacturing establishments; tanneries, abbatoirs, hat factories, dye works, etc. The night sewage is low in quantity and consists largely of leakage from house fixtures and of ground water. At times of rainfall and of melting snow the flow shows a decided increase, but for short periods only. The present flow at the beginning of 1912 is approximately 5,500,000 gal. daily. This figure is about 44% of the daily water consumption.

A typical hourly variation in the sewage flow is shown by the accompanying diagram, Fig. 1. The hourly variation in the character of the sewage is shown by analyses in Fig. 2.

The removal of the larger suspended and floating matters in the sewage may be effected by either of two methods. One of the receiving wells has an iron grid through which a great many holes, ½ in. in diameter, are drilled. The sewage flowing over this grid passes through the holes, leaving the solid matters on the iron plates, from which they are removed by a laborer and disposed of by burning under the boilers. In the other well the screening device patented by Mr. Weand is installed. Most of the time the sewage is screened by this device. This screen consists of a cylindrical framework of steel, 6 ft. in diameter and 12 ft. long, upon which No. 40 mesh wire cloth is fastened in removable segments. The wire cloth is protected by a ⅝-in. mesh No. 12 copper-wire screen. The segregator, as it is called, revolves slowly at the rate of about eight times per minute, and is kept clean by jets of water. The sewage enters at one end of the cylinder and passing through the cloth leaves behind practically all the larger suspended solids. The screenings are carried to the outlet end of the screen by a worm and then to a bucket conveyor, which empties into a hopper where some draining of the free water takes place. From the hopper the screenings are shoveled into bags and dried in a centrifugal machine. The dried screenings are mixed with coal and fired under the boilers.

The labor of handling the screenings is done by three men in eight-hour shifts. The operation of the screen and dryer require about 5 hp. The approximate cost of screening, outside of repairs, depreciation, etc., has been about $1 per 1,000,000 gal. The repair item is considerable, however. About once a month or six weeks the wire cloth becomes clogged with grease and the segments have to be removed and washed with caustic soda. This washing requires about 30 hours of extra labor. The tables of operation data show the amount of segregator screenings per million gallons treated for the years 1910 and 1911.

The amount of screenings per million gallons is, in round numbers, 1 cu.yd. for the segregator and 5 cu.ft. for the grid. The wet segregator screenings weigh about 60 lb. per cu.ft., and after drying from 30 to 35 lb. The composition of the screenings is shown by the following typical analysis:

COMPOSITION OF SCREENINGS

	Wet	Dried
From segregator:		
Moisture	89.5%	73.0%
Mineral matter	2.8	7.4
Volatile matter	7.7	19.6
	100.0	100.0
From grid:		
Moisture	79.6	
Mineral matter	1.8	
Volatile matter	18.6	
	100.0	

Estimating from these figures, it will be seen that the segregator removes near-

ly 25 parts per million of solids from the sewage, while the corresponding figure for the grid is 9 parts per million. The large bulk of segregator screenings

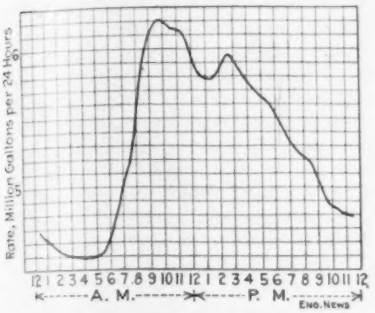


FIG. 1. HOURLY VARIATION IN SEWAGE FLOW, READING, PENN.

(Average of weir gagings for one week in January, 1912.)

is largely due to the high per cent. of moisture contained in them.

SETTLING TANK—After the screening the sewage is pumped through a 20-in. cast-iron force main to the preliminary settling tank, which is located about a mile below the pumping station on the opposite bank of the Schuylkill River. The tank is 250 ft. long, 50 ft. wide and 17 ft. deep, with a capacity of 1,600,000 gal. This tank was built on the site of the old Deery filters (ENG. NEWS, Vol. 39, p. 50, 1898), and the iron framework of these filters is incorporated in the tank as reinforcement. The tank is divided into five compartments by 4-ft. baffle walls, which extend up from the bottom of the tank. Each of these compartments is divided into four bays by cross-beams about 1 ft. high. The first compartment has no drain valve, but the other four are provided with 6-in. valves. The small number of drain valves and the bottom cross beams make the cleaning of the tank a much more difficult and expensive operation than would otherwise be necessary. On account of the 4-ft. baffle walls the actual storage capacity for flow is less than the capacity of the tank, this retention capacity being about 1,200,000 gal., upon the assumption that the volume below the top of the baffle walls is "dead". Thus for a rate of flow 4,800,000 gal. daily the retention period would be six hours. It is during this retention period that the sedimentation takes place. At the inlet end of the tank the sewage enters through 12 ports about 5 ft. below water level so that the velocity may be checked quickly. At the outlet end the sewage flows into a trough, which extends the total width of the tank, and thence into the gravity main leading to the sprinkling filters. At the weir of the trough there is a scum board, extending 1 ft. below the water level, but there are no other surface baffles on the tank. An overflow weir is provided in case the tank alone should be in operation and this empties into a concrete trough which leads into the river.

Although this tank was designed as a septic tank it has been operated as a sedimentation tank. This was done at first to avoid complications that might arise from the Cameron patents, but later it was found that frequent cleaning was an advantage in the operation of the filters. The effluent from the tank, when the contents were in a septic condition, would contain considerable amounts of suspended matter; much more than when the tank was in a quiescent state. Especially would there be an increase in the amount of nozzle clogging solids. At times of septic activity it has also been found that there is a greater tendency for the clogging of the filter surfaces.

The cleaning intervals vary with season, being most frequent in summer and least in winter. In winter the tank may go several months with very little bacterial activity, while in summer this activity may begin a week after cleaning. The minimum length of time between cleanings has been six weeks and the maximum four months. When bacterial activity is pronounced upheavals of sludge occur which bring to the surface quantities of scum-forming material. At no time since the operation of the plant began has there been any scum of a permanent character, for it has always been of such a character as to be easily broken up by wind or rain action. The presence of even a small amount of scum is not desirable, however, because, with wind blowing toward the outlet, the scum is more or less discharged with the tank effluent. Furthermore this scum has a disagreeable, greasy odor, while the sewage in the tank has practically no odor. The odor from this scum is seldom noticed save from the platform around the top of the tank. The accompanying photograph shows the absence of scum after four months of operation in winter without cleaning.

When the tank is cleaned the supernatent liquid is drawn off until the sludge is reached. The sludge is then run into lagoons made by throwing up earth embankments around about an acre of low land situated near the tank. The sludge fills this area to a depth of from 1 to 5 ft. This area has received all the sludge removed from the tank up to date but this area is practically used up. Up to the first of 1912 this area had received in all about 17,850 cu. yd. of wet sludge. The sludge flows by gravity from the tank but labor is required for shoving it to the drains and for shovelling it over the cross-beams in the floor. With the same degree of efficiency in the labor it requires no more labor to remove a large amount of sludge than a small amount because until the level of the beams is reached the sludge will flow out without needing any labor. Were every one of the small division bays provided with a drain valve it would require but one man to clean the entire tank in one day.

After each cleaning the contents of the lagoons shrink largely in volume, due to septic action and to draining and drying. In the deeper parts of the lagoons the sludge becomes a black, spongy, almost liquid mass covered with a thick leathery crust. In the shallow parts the sludge dries into an almost oderless porous material without becoming liquid. The lagoons themselves have given off but little odor, this odor being rarely no-

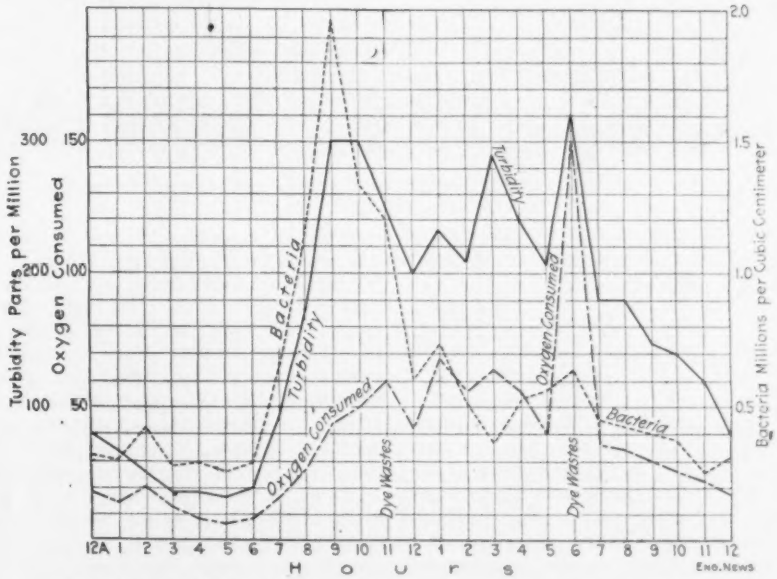


FIG. 2. HOURLY VARIATION IN CHARACTER OF SEWAGE, READING, PENN.

(Based on a 24-hr. test of screened sewage.)

ticeable at a greater distance than 100 ft. and usually not farther than 25 ft. The sludge varies in character according to the time of the year. In summer the sludge is very black, fine grained and homogeneous and with a practically non-offensive tarry odor, and gives absolutely no offensive odors when run into the lagoons. The winter sludge is brown, coarse-grained and composed of undigested solids and with a much more offensive odor. When the winter sludge is removed it has been found necessary to spread bleaching powder over the surface to prevent nuisance. This application of bleach has been found very efficient in the prevention of the spread of bad odors.

The efficiency of the tank varies with the velocity with which the sewage flows through it. The figures given below show the per cent. removals of turbidity and oxygen consumed for the years 1909, 1910 and 1911, with average rate of treatment and corresponding velocities; also the effect of increased velocity in reducing the efficiency of the tank:

Year	Rate mil. gals. daily	Velocity of flow, ft. per sec.	Per cent. reduction Turbidity	Per cent. reduction Oxygen consumed
1909	3.00	0.0083	59	49
1910	4.02	0.0112	48	40
1911	4.57	0.0128	32	27

The experience at Reading indicates that the tank treatment plays a very important part in the purification of the sewage and especially with septic action kept at a minimum by frequent cleanings. Even with poorly constructed floor the cost of sludge removal and disposal has been very low, averaging but five cents per million gallons of sewage treated, for labor of removal and throwing up dikes, although figuring in the cost of the land, the actual total cost of sludge disposal has been very close to 30c. per 1,000,000 gal. The method of disposal has proved fairly satisfactory in regards to odors and in four years of operation there has been but one even slightly justifiable complaint.

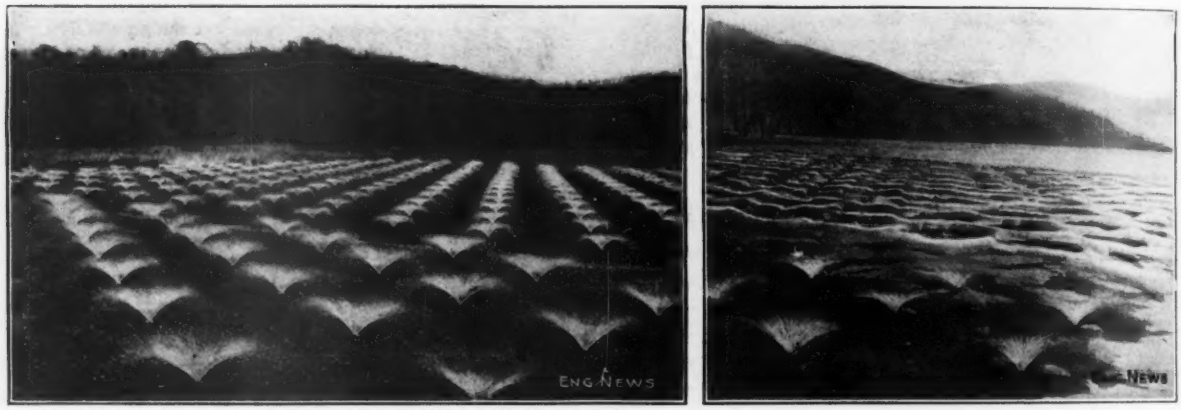
DATA OF CLEANING SEDIMENTATION TANK

Year	1910	1911
Million gallons sewage treated	1360	1528
Cu.yd. sludge	4167	8850
Cu.yd. sludge per mil.gal.	3.06	5.75
Removal cost per cu.yd.	1.6c.	0.8c.
Removal cost per mil.gal.	4.9c.	4.8c.
Solids	8.2%	9.2%
Volatile solids	..	5.6%
Fixed solids	..	3.6%

SPRINKLING FILTERS—From the tank the sewage flows by gravity through a 30-in. main to the three sprinkling filters on Fritz's Island, about 3000 ft. from the tank. These filters are each capable of treating 2,500,000 gal. of properly settled sewage per 24 hours. Each filter is built on the same general lines, but they differ in details of design. Each consists of a floor of concrete over which are laid lines of half-round tile, forming the collecting systems for the filtered sewage. These tiles are laid in parallel lines about an inch apart and with an inch between each tile. The floor pitches towards large main drains into which the tiles run. The pitch of the floor is about one per hundred. Over the tiles a 1-ft. layer of large stone aids in the underdrainage. Above this layer the regular filtering media is placed. The sewage is distributed through main distributors, then through lateral lines and riser pipes to sprinkler nozzles (see Fig. 3 and 4). The sewage application is controlled by dosing tanks arranged with automatic devices for the intermittent discharge of the sewage under varying heads. The division of the sewage flow to the three filters is through a weir tank located over the pipe line from the settling tank. The beds are numbered according to the plans for an ultimate layout of eight beds. No. 4, the first filter built and put in operation, was constructed under the Weand contract, while No. 2, the second bed, was built by the city, Chiles & Whitman being the contractors, and No. 1, the third, was built in 1911, being the last under the Weand contract.

Filters No. 1 and No. 4 are composed of slag to the average depth of 5 ft., this material being a particularly hard open-hearth furnace slag. This slag is rough and porous, breaking into nearly cubical pieces. The specific gravity of the slag is about 2.2. In placing the material on No. 4, no great attention was paid to avoid pocketing of either large or fine material, so that numerous places in the bed show either very large material or very small. Neither was there any particular care taken to get material of uniform size, so the pieces run from ½ in. to 6 in. On No. 1, much greater care was taken and the size runs from 1 to 4 in. Although designed to have 6 ft. of material, the contractor chose at his own risk to leave off the final foot on No. 1 and No. 4, leaving the riser pipes sticking into the air from 9 to 18 in. above the surface of the bed. This gives these beds a decidedly unfinished appearance and in very severe winter weather some trouble has been experienced with the freezing of nozzles. These filters are inclosed by a dry rubble wall. The dosing apparatus for No. 4 is a cylindrical wooden tank, whose discharge is controlled by an ingenious system of butterfly valves operated by floats. When the tank becomes filled a valve opens into the main distributing pipes and allows the sewage to be discharged; when the tank is empty the valve is closed and the bed rests. The period of discharge is about three minutes and that of rest about six. The dosing apparatus for both No. 1 and No. 2 are hopper-shaped concrete tanks, controlled by Miller automatic siphons.

Filter No. 2 is of broken stone, 6 ft. in average depth, and is surrounded by a concrete wall. The stone is a feldspar, which breaks into somewhat flat pieces along cleavage planes, the surface being smooth and the texture of the rock homogeneous. In building this filter, there was also considerable difficulty in getting the material of proper size and cleanliness, the result being that in spots there are pockets of fine and rather dirty stone.



FIGS. 3 AND 4. SEWAGE SPRINKLERS AT READING, PENN., UNDER ORDINARY AND EXTREME WINTER CONDITIONS

It is essential that the greatest care be used in the selection and placing of the filter material; "just a heap of stones" will not do. Stone should be nearly cubical in form, without cleavage planes and with fairly rough surfaces, but not porous. The stone must be hard and not liable to deterioration. Uniformity in size is also necessary to prevent packing which, after a while, will cause spots of clogging. If the surface of the material is too smooth there is less opportunity for the biologic life which plays such an important part in the working of the filters. On the other hand, too rough material tends to retain the accumulated solids and cause pooling and clogging. The top foot of material should be placed with the greatest care, for it is here that the most trouble is liable to occur from clogging. Neither the slag nor the stone fulfill all these requirements; the slag disintegrates somewhat and its roughness retards the washing out of solids, although its cubical shape and lack of cleavage planes is a distinct advantage. The stone tends to pack on account of its cleavage planes, but allows the solids to wash off more easily on account of its smoother surface.

The nozzles used for the distribution of the sewage upon the surfaces of the beds are modified forms of the Columbus type, the supporting arms for the spray deflector being beneath the orifice and the deflector attached to a concentric spindle. The spray is discharged in the form of a hollow cone. Each nozzle is the center of a hexagonal area on the filters. Filters No. 1 and No. 4 have each 218 nozzles and No. 2 has 254.

At times the filters accumulate large quantities of solids, which, if too great, cause the beds to become clogged and the sewage to stand in pools upon the surface. When the filters had been in operation but a year, it was thought that this clogging occurred only in the winter or early spring, but later experience has shown that clogging is liable to occur at any time. The strength of the filter influent and the biologic health of the filters are main factors in determining clogging. When filter No. 4 was first put into service, it received a very weak influent, extremely low in suspended solids and organic matter. Consequently this filter had many months of easy work, in which time to get into good condition biologically. When stronger sewage was applied, this filter had well established bacterial and micro-organic qualities.

Filter No. 2 was started at a time when the influent was fairly strong and had but a few months of work before cold weather. In No. 2, clogging began in January, 1910, the filter having been put into service in August of the preceding year. The clogging began in that portion of the filter which had had the least care taken of the quality of the filtering media. This clogging gradually extended over the entire bed and persisted until the second week in April, when it began to disappear, and by the end of April it was practically all gone. At the same time there was pooling on No. 4, but not nearly as extensive as on No. 2. At no time, however, was the pooling sufficient to materially depreciate the quality of the effluents or to allow any large amount of the sewage to remain on the surface of the beds. There were several features which contributed to the cause of this pooling.

In December, 1909, the entire plant was shut down for one week, to make certain necessary repairs and alterations at the pumping station, and during this period the filters had opportunity to get out of condition, especially No. 2, which had been in service such a comparatively short time. The presence of dirt and small stones also helped clog the filter material in No. 2. To remedy this clogging, portions of No. 2 were put out of service for periods ranging from three to four days to two weeks, with the hope that the solids would dry and wash out upon resumption of operation.

While this procedure had a slight effect on decreasing the clogging, it was not of any permanent benefit. The drying action took place to very little extent below the first two or three inches of the material. Another remedy tried was to dig into the bed for several inches, thereby letting the pools drain and admitting air into the voids of the stones. This also had but slight effect. With the advent of warm weather, it was found that the filters began to unload themselves of the accumulated solids, which had caused the clogging, and when this unloading was completed, the stones were as clean as though washed with a hose. At this time the unloading was ascribed to increased bacterial activity, due to the advent of warm weather. However, clogging again took place in the middle of September, 1910, and continued until the first of December. This time the pooling was not so extensive as the first. At the time this second clogging occurred the settling tank was in a pretty active state of fermentation and the filter influent contained large amounts of suspended matters. This time the total area of the filter was kept in service and the material turned over at spots of the worst conditions. It was also found that the bleaching powder was a help in cleaning the filtering media and a small area of the filter was cleaned in this way. As soon as cooler weather began, the tank cleaned and with little activity the pooling began to disappear and had completely gone by the first week in December.

During both these attacks of clogging it was noticed as the improvement began that there were enormous numbers of small white or pinkish worms massed upon the filter stones and that these worms were not present in the middle of clogged spots, but around the edges, and that with the increase in worms there was a decrease in clogging. It seemed as though the worms were attacking the solids and breaking them away from the stones, so that these detached solids could be washed off by the sewage flow. It also seemed as though the activity in the settling tank had a tendency to prevent the growth of these worms, due probably to the production of bacterial poisons. In 1911, clogging was practically absent until November. During the late Summer and fall a storage of solids took place in the filter material and clogging has been present to the first of 1912, without any decrease.

In summer there are countless numbers of a small grayish fly, which swarm about the filters and which breed in the top layers of the filtering material. They are present from about the first of April until the first of November, although they may be found in small numbers underneath the filter stones during the winter. Fortunately, these flies do not travel far from the filters, as they are a nuisance within about fifty feet of the beds. Usually they do not travel more than one hundred feet from the beds. These flies

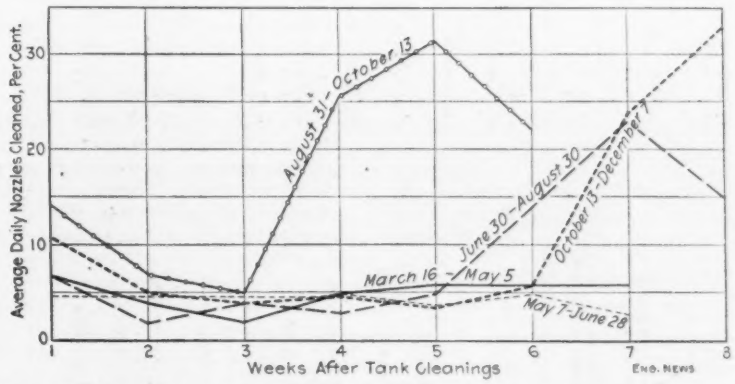


FIG. 5. DIAGRAM SHOWING AVERAGE DAILY PERCENTAGE OF SEWAGE-SPRINKLER NOZZLES CLEANED EACH WEEK AFTER CLEANING SETTLING TANK, READING, PENN.

have a foe in large numbers of small red spiders, which live on the filter surface.

While in operation the surface of the filters becomes covered with a green growth of algæ, resembling Botryococcus. This growth is more luxuriant in summer than in winter, but is present at all times of year. At no time has this algæ growth been a contributing factor in causing clogging. It dries very rapidly when the filters are out of operation and peels off in thin black films. A drying filter gives off an odor resembling a salt marsh, probably from the algæ.

At no time has there been any serious odors given off by the filters; in fact, their freedom from odors is particularly noteworthy. Ordinarily the greatest distance at which even the slightest smell can be detected is but 10 or 15 ft. from the filters. Once in a great while, on damp days, a slight odor may be noticed at 100 yd. from the filters, but never at a greater distance.

The formation of ice on the surface of the filters has never interfered with their operation, although, as noted previously, some trouble has been experienced with nozzles freezing on filters No. 1 and No. 4. The ice formation on filter No. 2 is less than that on filters No. 1 and No. 4, because the nozzles are nearer together. The photograph shows the ice formation after the most severe weather experienced in four years of operation, the minimum temperature being minus 21° F.

Comparatively little labor is required in the operation of the filters. Three men are employed in eight-hour shifts who do the work required and who also act as watchmen. These men collect samples for analysis, take care of the laboratory and keep the grounds in condition. They are paid $2 per day, so the labor cost is a little over $1 per million gallons treated.

On account of the irregular operation of the screen considerable amounts of coarse material is brought to the settling tank, some of this material settles out, but some gets carried to the filters, where it tends to choke up the sprinkler nozzles. When the tank becomes active with the decomposition of the deposited sludge, the gas bubbles bring lumps of sludge to the surface, which, when carried to the nozzles, cause them to clog. The clogging materials consist of burnt matches, peanut shells, bits of tallow, etc. When these things get lodged in the nozzle orifices the spray becomes irregular, and once in a great while the orifice may become stopped up completely. The number of nozzles requiring attention during a day is not large, and one man spending four to five hours per day has no trouble keeping the nozzles of three beds in excellent condition. The diagram, Fig. 5, shows the percentage cleaned for each week after the settling tank has been cleaned. This shows the effect of septic activity in sending clogging materials to the filters.

Referring to Fig. 5, it will be seen that there is a marked increase in the number of nozzles requiring cleaning in the late summer and early fall, which corresponds to the time of greatest activity in the settling tank. It will also be noticed that there is very little direct connection between the length of time that the segregator has been out of service and the number of nozzles cleaned. While undoubtedly the use of the screen tends to keep down the clogging of the nozzles, it is evident that the principal feature determining this number is the condition of the settling tank, which in turn depends upon the frequency of cleaning and the time of year.

The filters require very little care save for the cleaning of the nozzles. The lines

SUMMARY OF RESULTS OF READING SEWAGE PURIFICATION WORKS, 1910

Month	Segregator screenings, cu.ft. per million gal.	Daily quantity sewage filtered, million gal.	Acres of filter surface	Daily per cent. of nozzles cleaned	Temperature: Screened sewage	Temperature: Final effluent	Turbidity: Screened sewage	Turbidity: Filter influent	Turbidity: Final effluent	Parts per million: Oxygen consumed: Screened sewage	Oxygen consumed: Filter influent	Oxygen consumed: Final effluent	Nitrates: Final effluent	Dis. oxy.: Final effluent	Putrescibility: Final effluent	Bacteria Millions per c.c.: Screened sewage	Filter influent	Final effluent	Per cent. removed
Jan	33	3.67	2	9	50	44	196	67	22	56	29	13	7.0	8.0	0	2.24	1.62	0.42	81
Feb	31	3.81	2	9	50	45	194	91	23	45	31	16	5.1	7.5	0	1.87	1.62	0.42	78
Mar	29	3.54	2	6	53	51	155	100	21	52	34	16	6.5	7.3	0	1.86	1.32	0.42	77
Apr	34	3.83	2	4	58	58	194	93	19	61	32	16	6.3	6.4	0	1.88	1.77	0.42	78
May	35	3.50	2	5	61	62	140	71	21	48	26	15	6.9	5.8	0	2.57	1.50	0.47	82
June	36	3.56	2	4	64	65	161	85	17	47	28	13	6.0	4.8	0	2.16	1.33	0.89	59
July	34	3.82	2	5	71	73	120	63	14	41	26	13	4.2	4.8	0	1.96	0.80	0.50	75
Aug	33	3.62	2	15	71	72	169	105	17	44	30	13	3.8	5.0	0	3.32	0.94	0.23	93
Sept	24	4.44	2	14	70	68	145	80	14	45	29	13	4.3	5.3	0	3.02	0.80	0.30	90
Oct	32	4.06	2	11	65	62	160	95	17	49	33	14	4.1	6.7	0	3.50	0.95	0.26	93
Nov	31	4.36	2	8	57	52	190	104	20	60	37	15	5.2	7.2	0	2.48	1.60	0.29	88
Dec	25	4.34	2	12	50	45	197	105	23	60	37	18	5.0	8.3	0	2.31	1.41	0.26	89
Average	31	3.88	..	8	60	58	169	88	19	51	30	15	5.4	6.4	0	2.43	1.32	0.41	83

SUMMARY OF RESULTS, READING SEWAGE PURIFICATION WORKS, 1911

Month	Segregator screenings, cu.ft. per million gal.	Daily quantity sewage filtered, million gal.	Acres of filter surface	Daily per cent. of nozzles cleaned	Temperature: Screened sewage	Temperature: Final effluent	Temperature: Mean atmospheric	Turbidity: Screened sewage	Turbidity: Filter influent	Turbidity: Filter effluent	Parts per million: Oxygen consumed: Final effluent	Oxygen consumed: Screened sewage	Oxygen consumed: Filter influent	Oxygen consumed: Filter effluent	Nitrates: Final effluent	Nitrates: Filter effluent	Dis. oxy.: Final effluent	Putrescibility: Final effluent	Putrescibility: Final effluent	Bacteria Millions per c.c.: Screened sewage	Filter influent	Filter effluent	Final effluent	Per cent. removed
Jan	23	4.72	2	10	48	44	33	173	106	84	36	49	32	23	18	3.7	5.0	7.6	0	1.86	1.34	0.31	0.27	86
Feb	21	4.92	2	12	48	43	33	174	124	73	33	46	34	21	16	5.4	6.4	7.4	0	2.79	1.91	0.38	0.32	89
Mar	23	4.54	2	10	48	45	38	165	121	41	28	43	29	18	15	4.9	5.9	7.5	0	3.12	1.99	0.46	0.37	88
Apr	25	4.80	2	7	53	53	48	171	96	32	18	40	29	18	14	5.9	7.5	6.1	0	3.28	2.03	0.34	0.31	91
May	23	4.46	2	5	64	65	66	119	85	33	18	31	23	19	14	7.2	7.3	4.9	0	3.60	1.91	0.35	0.47	87
June	26	4.64	2	9	67	69	71	117	87	27	16	39	30	20	19	5.4	6.0	4.2	0	4.55	1.57	0.28	0.37	92
July	25	4.42	2	10	71	74	77	154	101	38	16	38	27	18	14	3.5	3.8	4.4	0	3.21	1.61	0.34	0.33	90
Aug	28	4.24	2	20	72	74	74	145	100	23	13	37	26	14	12	3.9	3.9	4.2	0	3.22	1.38	0.22	0.29	90
Sept	..	2.98	2	11	69	69	63	136	79	18	13	41	26	15	13	4.3	4.6	5.5	0	..	1.20	0.25	0.12	..
Oct	26	2.72	3	10	63	59	53	148	103	19	13	37	27	15	11	4.7	4.4	6.6	0	2.80	1.21	0.30	0.53	81
Nov	28	3.85	3	13	59	50	39	150	110	18	12	34	25	12	12	4.6	4.7	6.8	0	2.96	1.33	0.40	0.52	82
Dec	23	4.35	3	9	55	50	37	159	111	24	12	35	25	14	15	4.9	5.4	7.4	0	2.16	1.47	0.41	0.39	81
Average	24	4.22	..	9	60	58	53	151	102	36	19	38	28	18	14	4.9	5.4	6.1	0	2.80	1.63	0.34	0.36	87

of lateral distributors are flushed frequently, thus keeping the lines clean. As yet it has not been necessary to flush any of the lateral underdrains. At first, when clogging of the media occurred, some time was devoted to turning over small portions of the top layer at the worst spots, but now this is not done at all, and we simply wait until the filter gets ready to clean itself. The dosing apparatus for filters No. 1 and No. 2 needs no attention, but that of No. 4 has to be oiled and adjusted frequently.

FINAL SEDIMENTATION BASINS—The effluents from the filters are given a final sedimentation in shallow basins, holding about 300,000 gal. The object of these basins is to collect the suspended solids present in the effluents, which at times of washing out of the filters, are very high. Each basin is approximately 100 ft. square and is about 3.5 ft. deep at the inlet and 5 ft. at the outlet side. The filter effluents enter the respective basins through several ports, four in No. 1 and No. 4 and eight in No. 2. The walls of Basins No. 1 and No. 4 are at an angle of about 45°, while the walls of No. 1 are vertical. Vertical walls are better because accumulations of sludge take place on the sloping walls, which are unsightly. Opposite the inlet side each basin has a weir extending across the width of the basin, over which the effluent flows into a pipe leading to the river. The basins are provided with sumps for receiving the suction hose of a pump at times of cleaning, and are also provided with drain valves for removing the supernatent liquid.

The intervals between cleanings varies with the time of year and also according to the extent with which the filters are unloading. In winter the interval may be as great as four months and in summer as short as one month. When considerable quantities of sludge have accumulated in the basins, a secondary fermentation begins to take place and lumps of sludge are brought to the surface, which give an unsightly appearance to the basins, and, if not broken up by wind action before reaching the overflow weirs, give an increased amount of suspended matters in the final effluent. As soon as any amount of this secondary fermentation takes place, the basins are drained and the sludge removed.

The sludge removed from the basins during the warmer summer months is very black, liquid and with a sharp acrid odor. This sludge dries rapidly and loses its odor in a short time. The winter sludge has a higher per cent. of solids, is brownish and with considerable more odor. When the white worms are present in the filters they are washed out into the basins and often the basin sludge is full of these worms. The thoroughly dry sludge has no offensive odor, it smells very much like garden soil rich in loam. Up to 1912, the removal of the sludge has been effected by a diaphragm pump worked by hand, three men being needed for cleaning, two at the pump and one in the basin scraping the sludge to the sump. The hand pump has now been replaced by a gasoline pump, and the labor of the two men replaced.

DATA OF CLEANING FINAL SEDIMENTATION BASINS

Year	1910	1911
Million gallons sewage treated	1377	1427
Cu.yd. sludge	2655	2452
Cu.yd. sludge per mil.gal.	1.93	1.72
Removal cost per cu.yd.	4.8c.	5.0c.
Removal cost per mil.gal.	9.2c.	8.5c.
Solids	5.3%	5.3%
Volatile solids	...	2.9%
Fixed solids	...	2.4%

In order to keep definite record of the results accomplished as required by the State Department of Health of Pennsylvania, samples are collected for analysis at such times of day as will give approximate average samples. The accompanying tables give the average monthly results obtained during 1910 and 1911. The analytical methods used have been in the main those recommended by the Committee on Standard Methods of the American Public Health Association. Turbidities below 100 have been determined by silica standards and above 100 by a Jackson candle turbidimeter; oxygen consumed by the Kubel method boiling five minutes; nitrates by the phenolsulphonic-acid method; oxygen dissolved by Winkler's method; putrescibility by incubating undiluted samples with the addition of methylene blue for five days in 1910 and seven days in 1911, at room temperature of about 60° F.; bacteria have been determined by plating with gelatin media and incubating for four to five days at 60° F.; the longer period of incubation and lower temperature prevents trouble with liquefiers.

The operation of the plant is under the Board of Public Works, of which E. B. Ulrich is chief engineer, and E. B. Hedden is assistant engineer; the writer is chemist in charge of the plant.

Another Lock-Gate Accident in the Welland Canal

BY EMILE LOW*

The issue of ENGINEERING NEWS for July 11, 1912, chronicled an accident to the gates of Lock 22 of the Welland Canal which occurred on Thursday, June 20, 1912. Another accident on this canal happened on Friday, Aug. 2, 1912, this time to Lock 23, both the upper and the lower gates being carried away as the result of the collision of a steamer.

The wooden freight steamer "Wiley M. Egan," 252.2 ft. long, 39.8 ft. in breadth and 20 ft. deep, with a gross tonnage of 1677 and a net tonnage of 1380, built in Cleveland, Ohio, in 1887, and carrying a crew of 17 men, was bound light from Deseronto to Ashtabula to load coal. It had entered Lock 23 under good control; approaching the upper gates, the captain gave the required bells to reverse and stop the boat. The engineer understood the signal, but was unable to control the advance of the boat, with the result that it crashed into the upper gates (head), carrying them away. The inrushing water from the upper level, Locks 23 and 24, carried the boat back some distance, the stern striking the corner of a bridge over a narrow channel which connects the canal prism and the equalizing basin alongside. A hole was punched in the boat, but it was soon repaired and the boat did not sink.

The protection (or stop) logs along the west bank of the canal prism were washed out into the adjoining embankment, the flood of water also overtopping the same and doing some little damage to the tracks of the Grand Trunk Ry., which runs immediately along the base of the embankment.

Fortunately, there was no loss of life, as was the case when the government steamer "La Canadienne" carried away the gates of Lock 22, which is located about 900 ft. below Lock 23.

New gates were sent up at once from Port Dalhousie on Lake Ontario (a supply being kept there all the time), and installed Saturday, Aug. 3, 1912. The canal was out of commission a comparatively short time.

This is the third time this season that the Welland Canal has been tied up by accidents to lock gates.

The levels between Port Dalhousie and Thorold, Locks 1 to 25, inclusive, are comparatively short ones, the distance being about nine miles. The summit level, however, is about 18 miles long. To guard against what might be very serious consequences, a guard-gate is located about 900 ft. south of Lock 25, the end of the summit level. This guard-gate is invariably kept closed whenever the gates of Lock 25 are open as well as at other times when no traffic is passing Lock 25, lock tenders being stationed at both places.

To regulate the opening and closing of these upper gates, two semaphores are installed, one at each place (Guard-gate and Lock 25). As the distance between is short, about 900 ft., they can readily be seen by the lock tenders, their operation thus being "visual." They are also provided with white and red lights for night work. The opening or closing of the gates operates these semaphores automatically.

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Statistics of Railway Accidents in Pennsylvania for both steam and electric roads during the first half of the year 1912 show an increase of 1399 over the number for the corresponding period in 1911. The state railroad commission received reports of 7566 accidents, of which 644 were fatal. For the corresponding period in 1911 the number killed was 631.

FIELD AND OFFICE

Methods and Costs of Applying Stucco with the "Cement Gun"

By R. C. Hardman*

The writer recently has had occasion to use the "cement gun" for placing stucco on the exterior of a small frame building, containing 631 sq.yd. of surface and having 56 door and window openings. He gives below the methods and cost of doing the work.

The building, which is two stories high, consisted of a main front with two rear wings, in the space between which the gun was stationed, with the sand and cement storages immediately behind. The typical force in the operation of the gun was one man running the engine and gun, two men mixing and sacking dry material and charging hopper, one nozzleman, one laborer to help nozzleman, and two laborers cleaning grounds and screeding.

The entire building was first covered with cheese-cloth, then with a cheap grade of building paper secured by laths running vertically on the studs. This was then covered with mesh reinforcement secured by 1½-in. staples. Grounds were placed on alternate studs to give a stucco thickness of 1¼ in. The panels thus formed were filled alternately to within about ¼ in. of the face of the grounds. The grounds were then cleaned off with a small trowel and about thirty minutes later the stucco was brought flush with their face and screeded off. The screeding was done by unskilled Mexican labor with a straight-edge shod with steel. When these panels were set, the grounds were removed and the panels between were filled in the same way. The work was done in four sections vertically. The top section was done first so that falling material might find a lodging place below. When a section was completed it was lightly sprayed to secure uniform color and cover up joints. The mixture used throughout was one part of portland cement to three parts of sand.

In shooting the mixture onto the wall the nozzleman stood so that the nozzle was from three to four feet from the wall, and kept the nozzle in continual motion so as not to pile up too much mortar in one place. In accordance with the principle of the device, the dry mixture was mixed with water at the nozzle. The amount of water used was just enough to keep the mortar below the running point. Water was delivered at about 40 lb. pressure. The air pressure used was 26 lb. A higher pressure than this caused too much waste of material (mostly sand) by rebounding and a lower pressure tended to clog the hose with dry material.

The apparatus consisted essentially of an engine, an air compressor and the "cement gun," which is a hopper, having a caisson lock, for receiving the dry material and from which it is forced through a hose to the surface to be covered. As used the outfit comprised a 4-cycle, 4-cylinder gasoline engine, connected to a 2-cylinder single-acting air compressor by means of belt and pulley operated by a belt tightener. On the front end of the engine and operated by its flywheel was a small water pump for the engine water-cooling system. A second water pump attached to the compressor and operated by its flywheel was available for pumping water to the hose nozzle. Neither of these pumps was used, as the water pressure from the mains was sufficient.

Connected to the air compressor was the hopper or "cement gun" proper. This consisted of two connected air chambers —upper and lower—each closed at its top by a flap valve hinged to swing downward by gravity and closed by outside levers. The feeding mechanism, which consisted of a revolving slotted wheel, was at the bottom of the lower chamber and allowed the dry mixture to fall through and be forced through a hose, at the nozzle of which it was mixed with the proper amount of water.

In operation the lower chamber was first closed by its valve and filled with air. The dry mixture, which previously had been sacked for convenience, was put into the upper chamber, the upper valve closed and the air turned in. As soon as the pressure in the upper chamber equaled that in the lower the valve connecting the two chambers opened by gravity, allowing the dry mixture to fall into the lower chamber where the revolving slotted wheel allowed it to feed through into the hose connected to the bottom of the lower chamber under the feed wheel. When sufficient material had been forced from the lower chamber to allow its valve to be closed, the exhaust from the upper chamber was opened and the pressure reduced until the lower valve was held closed by the pressure in the lower chamber. The upper chamber was then again filled with the dry mixture, so that the feeding and discharge through the hose was continuous and uniform.

The feeding mechanism was operated by a paper wheel and friction disk controlled by a lever. The dry mixture passed through the feed wheel into the hose and was then picked up by air directly from the compressor and forced through the hose. The hose used was a 2-in. steam hose.

In the accompanying table is given an itemized statement of costs:

TABLE SHOWING COST OF STUCCOING 631 SQ. YD. OF SURFACE WITH CEMENT GUN

		Cost	Cost per Sq.Yd.
Material for Lathing:			
Cheese cloth 631 sq.yd. at	$0.035	$22.9	
Building paper 56.8 squares at	0.30	17.04	
Wire, 631 sq. yd. at	0.1278	80.64	
Lath, 500 sq.yd. at	5.25M	2.63	
Nails, 10 lb. at	0.04	0.40	
Staples, 200 lb. at	0.0425	8.50	
		$131.30	$0.2081
Labor for Lathing:			
Carpenters... 16 hrs. at	$0.5625	$ 9.00	
Carpenters... 59 " "	0.50	29.50	
Carpenter helpers.....144 " "	0.375	54.00	
Laborers..... 33 " "	0.218	7.22	
Laborers:Mex;41.5" "	0.156	6.49	
		$106.21	$0.1683
Total for Lathing		$237.51	$0.3764
Material for Plastering:			
Portland Cement 65 bbl. at	$3.43	$222.95	
Sand (at site)			
		$222.95	$0.3533
Labor for plastering:			
Nozzleman.... 96 hrs. at	$0.5625	$54.00	
Engineer.....100 " "	0.375	37.50	
Laborers, mixing.....212 " "	0.156	33.13	
Laborers on wall.....156 " "	0.166	26.00	
Laborer (hose).59 " "	0.218	12.94	
		$163.57	$0.2592
Fuel:			
Gasoline, 97.5 gal. at	$0.22	$21.45	
Lubricants		4.90	
		$ 26.35	$0.0418
Total for plastering		$412.87	$0.6543
Total		$650.38	$1.0307

Time: 12 days.
AVERAGE: 52.51 sq. yd. per day

The resulting cost per square yard appears rather high, but it must be remembered that the stucco is 1¼ in. thick (the average thickness is somewhat more owing to the stretching of the cloth between studding), the cement is high in cost, and efficient labor difficult to secure. The nozzleman was an experienced man, but all other labor was unfamiliar with the work.

As the building covered was relatively small and badly cut up by openings, the results given above are perhaps not quite fair to the "cement gun" as too much time was lost in moving the hose lines and the consequent starting and stopping, which has a tendency toward clogging the feed hose. Time was also lost by the wearing out of the feed hose about a foot from the hopper, due, ap-

*Civil Engineer and Superintendent of Construction, U. S. War Dept., Fort Huachuca, Ariz.

parently to a whirling motion of the sand as it came from the hopper.

As has been stated the gun was placed in a recess in the rear of the building so that the entire job was done without moving the plant. Fifty feet of hose was used and all parts were reached by running through window and door openings.

On the whole the apparatus is considered a success, certainly so if used on comparatively large surfaces where little changing of position is required. The quality of stucco secured is the principal argument in its favor.

Improved Flow-Plate Apparatus for Comparing the Consistency of Bituminous Cements

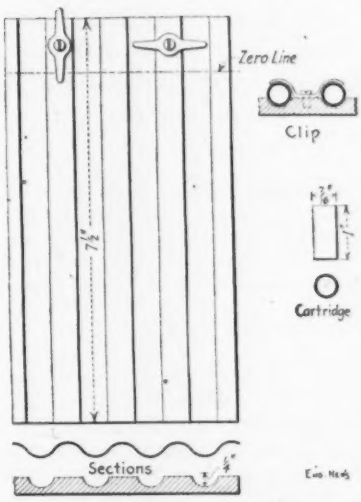
By S. Whinery*

The simplest practical method, for use in the field or at the mixing plant, of determining the relative consistency or hardness of bituminous cements composed of different ratios of the same materials is the now well known flow-test. It consists in comparing the relative flow of like cylinders of the bituminous cement upon grooved plates when exposed to a melting temperature.

The principal difficulty in its use lies in making accurately the cylinders of cement to be tested. If molds are used they are somewhat expensive and require skill and experience for their proper manipulation; if, as is sometimes the case, the cylinders are prepared by rolling out the material between flat surfaces, they are likely to vary in diameter and volume enough to seriously affect the results. I have recently hit upon a very simple device for overcoming these difficulties, which may be of sufficient interest to warrant its description. It consists in substituting for the naked cylinders of cement short copper tubes filled with the cements to be compared.

The filled tubes may be called cartridges. The tubes are made of standard seamless drawn copper tube, having an external diameter of approximately $\frac{7}{16}$ in., cut to accurate lengths of 1 in.; the thickness of the metal is No. 19, Stubs gage. In use, these cartridge shells are set on end and filled with the cements to be compared, the cement being shaved off accurately at the ends of the tube with a wet knife. The contained cylinders of cement thus made are accurately of the same dimensions, and contain equal quantities of cement.

The filled cartridges to be tested, after being cooled to a uniform temperature, are placed on the grooved plate and held there by a simple spring clip, and the plate exposed, in an inclined position, to some uniform source of heat. As the heat is absorbed by the cartridges their contents will begin to melt and flow down the grooves, and the consistency or hardness will be quite accurately measured by the length of the flow. If, say, four samples are thus tested together, two of them being of the cement adopted as standard and two of the sample to be tested or compared, the average relative length of flow of each set will show how closely the sample conforms to the standard.



Flow-plate and Cartridge Shell for Consistency Tests of Bituminous Cements

The sketches in the cut herewith will make clear the construction and use of the device without further explanation. The plate may be of sheet copper or brass, machine corrugated, as shown by the upper section, or may be made by planing out the grooves on a thicker plate as shown by the lower section. The latter is preferable, as the grooves are true and polished, and the greater mass of metal promotes a more uniform distribution of the heat. In placing the cartridges they should be set with their lower ends accurately to the cross-line on the plate. The flowing streams of cement should be allowed to reach a length of four or five inches before measurement.

It will be seen that this apparatus is very simple and inexpensive, and its use requires only ordinary care and skill. If a supply of the plates and tubes is placed in the hands of the inspector at the paving plant, with instructions to test against the standard every kettle of new cement made up, and to require that any kettle of cement not conforming to the standard consistency shall be made to do so, a degree of uniformity not now very usual in ordinary practice may be secured.

Authorities may differ as to the degree of uniformity in consistency that should be required. In a set of instructions to inspectors of sheet asphalt pavement, recently prepared by me, I have said:

> If the average flow of the new samples differs more than 5% from that of the standard, the new cement should be regarded as unsatisfactory and should be corrected by adding more asphalt or flux as may be required.

*Consulting Engineer, 95 Liberty St., New York City.

A Filing Systen for Catalogs

In the June issue of the *Journal* of the Engineers' Society of Pennsylvania, George S. Comstock, a manufacturer of Mechanicsburg, Penn., describes an excellent system for filing catalogs and trade bulletins as follows:

I have tried several systems, which worked well for a while, but which, in time, became top-heavy through lack of uniformity in size of trade circulars and of elasticity in the system of filing. I have now adopted a decimal system of classification, similar to the well known Dewey system used for cataloguing libraries, and the scheme has worked so well that it is given here in detail. I divide all materials, finished and unfinished, under nine general heads as follows:

1.00 General.
2.00 Mechanical Engineering.
3.00 Electrical Engineering.
4.00 Hydraulic Engineering.
5.00 Agricultural Engineering.
6.00 Civil Engineering.
7.00 Mining and Metallurgy.
8.00 Sanitary Engineering, Chemistry.
9.00 Architecture, Art.

I should say at once that these particular divisions, and subsequent subdivisions are not offered as by any means ideal, but grew out of a gradual development of the new scheme, while abandoning the old.

Now the above headings will care for only a very small and little-used file, and here is where the decimal system is made use of. Suppose, for example, as in my own case, one is chiefly interested in Mechanical Engineering. We will then need to develop the second heading, 2.00, and in my file this is done as follows:

2.00 MECHANICAL ENGINEERING.
2.10 Machine shop.
2.20 Wood shop.
2.30 Smith shop.
2.40 Boiler shop.
2.50 Power plants.
2.60 Foundry.
2.70 Hoisting and handling materials.
2.80 Transmission of power.
2.90 Compressed air.

Going further in the direction in which I am chiefly interested, the development of Compressed Air (2.90) follows:

2.90 COMPRESSED AIR.
2.91 Technical literature.
2.92 Air compressors, General.
2.93 Air tools, General.
2.94 Advertising, Special.
2.95
2.96
2.97 Compressed-air pumping.
2.98 Compressed-air transmission.
2.99 Compressed air, Miscellaneous.

Going still further, heading 2.92 expands into this:

2.92 AIR COMPRESSORS, GENERAL.
2.921 Steam driven air compressors.
2.922 Belt driven air compressors.
2.923 Electrically driven air compressors.
2.924 Vacuum pumps.
2.925 Hand-operated air compressors.
2.926
2.927
2.928
2.929 Air compressor parts.

and 2.93 is expanded into

2.93 AIR TOOLS, GENERAL.
2.931 Compressed-air hammers and riveters.
2.932 Drills.
2.933 Grinders.
2.934 Hoists and motors.
2.935 Stone cutting.
2.936 Forges.
2.937 Sand blast.
2.938 Nozzles for spraying, painting, etc.
2.939

while 2.98 is subdivided thus:

2.980 COMPRESSED-AIR TRANSMISSION.
2.981 Air hose.
2.982 Air hose couplings.
2.983 Air receivers.
2.984 Air valves.

It is evident that each of the original headings may be in like manner expanded to meet the requirements of each office, and it will also be noted that there is no limit to the expansion of any subject.

In connection with this system I use two card indexes, one for names and one for commodities. A name card may refer to several different file numbers, as for example:

Ohio Injector Co.	
Injectors	2.512
Lubricators	1.70
Brass Valves	4.32

and in like manner a subject card may contain the names of many manufacturers of, or dealers in, that particular article, for example:

Vises	2.16
See also Foot Vises, Pneumatic Vises.	
Tower & Lyon, New York,	2.16
Columbian Hardware Co., Cleveland,	2.16
Herman Boker & Co., N. Y.,	2.16
Powell, Clouds & Co., Philad.,	2.16
Hollands Mfg. Co., Erie,	2.16

When trade literature is to be filed, it is stamped with date of receipt and a place for the proper file number, as well as checks for indexing by name and one or more subjects. If the literature received is not of particular interest, it may be filed under any heading from the original head, down to whatever subdivisions may have been made. In practice, in an office where compressed air has but slight interest, a circular marked 2.982 could be filed in 2.00 if not subdivided, or 2.90, etc., with the advantage that if subdivisions are ever made, the circulars are ready to go into the proper place.

A standard vertical filing case will care for such a filing system, or the common box files may be used. In either case, under present conditions, bound books must be cared for separately, although they are marked according to the same system.

Several years ago I adopted 8½x11 in., as a standard for all my own circulars and office forms, in loose sheets, arranged for standard punching. My catalogs are built of loose sheets, each sheet being devoted as nearly as may be to a single machine or subject with a surprising saving in printing bills, and a resulting up-to-dateness impossible in bound books. So satisfactory has been my experience that I hope for the day when all the trade literature I receive will conform to some such standard.

Card Systems of the New York Navy Yard for Building-Repair Records and Correspondence

By Herman Block

The plans and methods here described for routine inspections, periodic examination of structures and equipment, filing systems and a follow-up system in correspondence have been devised by and are in use in the Public Works Department of the New York Navy Yard.

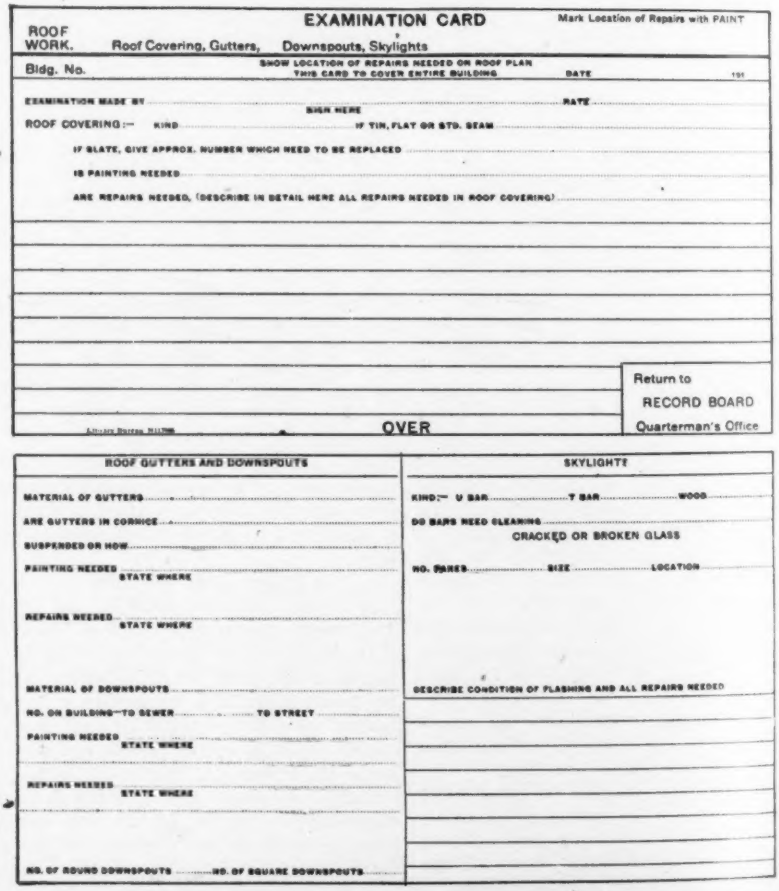
A navy yard is, in effect, a large industrial works for the building and repair of naval vessels, besides being a military establishment having to do with the fitting out of these vessels with provisions, ammunition, equipment and men. The New York Navy Yard employs between 3500 and 5000 mechanics and laborers, depending upon the amount of work on hand. In case of war, this number would undoubtedly be increased several-fold, so that the plant itself must be organized and laid out with a view to such extension.

The actual work of building and repair of ships and machinery is under a Manufacturing Department, consisting of two divisions—the hull and the machinery divisions. The plant itself, including grounds, buildings, docks, drydocks, power plant, railroad tracks, paving, sewers, steam, air and water pipes, railroad rolling stock, and various other appliances and equipment, is under a Public Works Department.

Inspection of Structures

In carrying out work of a routine nature involving upkeep and maintenance of a plant, experience has shown that it is difficult if not well-nigh impossible to secure satisfactory results without some sort of periodic examination of structures and equipment. Such examinations are indispensable to show where repairs are needed and to keep buildings and equipment in efficient condition. Unless, however, the records of such inspections are entered in a suitable file, which will insure not only that they are easy of access but that the repairs needed will be made and the defects remedied, the value of the inspection is negligible.

A system of inspection has been devised to discover leaks in roofs of buildings and window glass broken, and to insure the regular cleaning out of gutters and downspouts. This is supple-


EXAMINATION CARD

Mark Location of Repairs with PAINT

ROOF WORK. Roof Covering, Gutters, Downspouts, Skylights

Bldg. No. SHOW LOCATION OF REPAIRS NEEDED ON ROOF PLAN THIS CARD TO COVER ENTIRE BUILDING DATE 191

EXAMINATION MADE BY SIGN HERE RATE

ROOF COVERING:— KIND IF TIN, FLAT OR STD. SEAM

IF SLATE, GIVE APPROX. NUMBER WHICH NEED TO BE REPLACED

IS PAINTING NEEDED

ARE REPAIRS NEEDED, (DESCRIBE IN DETAIL HERE ALL REPAIRS NEEDED IN ROOF COVERING)

Return to RECORD BOARD Quarterman's Office

OVER

ROOF GUTTERS AND DOWNSPOUTS

MATERIAL OF GUTTERS

ARE GUTTERS IN CORNICE

SUSPENDED OR HOW

PAINTING NEEDED STATE WHERE

REPAIRS NEEDED STATE WHERE

MATERIAL OF DOWNSPOUTS

NO. ON BUILDING—TO SEWER TO STREET

PAINTING NEEDED STATE WHERE

REPAIRS NEEDED STATE WHERE

NO. OF ROUND DOWNSPOUTS NO. OF SQUARE DOWNSPOUTS

SKYLIGHTS

KIND:— U BAR T BAR WOOD

DO BARS NEED CLEANING

CRACKED OR BROKEN GLASS

NO. PANES SIZE LOCATION

DESCRIBE CONDITION OF FLASHING AND ALL REPAIRS NEEDED

Fig. 1. Card for Record of Roof Inspections, New York Navy Yard (Front of card above, back below.)

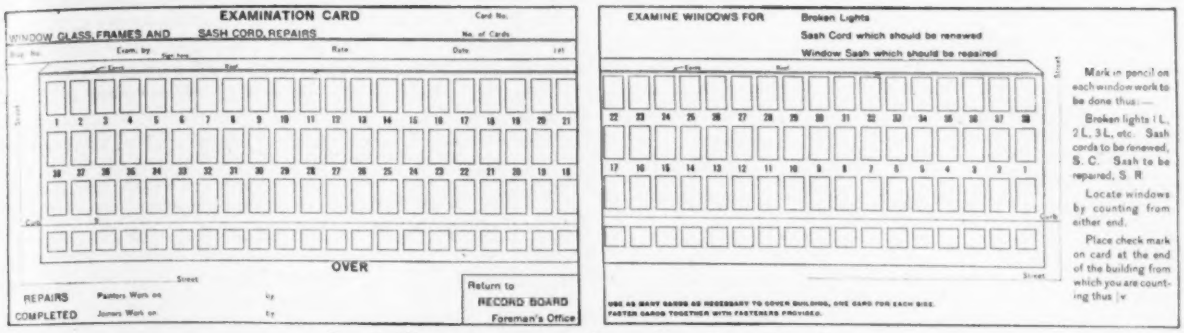

EXAMINATION CARD
WINDOW GLASS, FRAMES AND SASH CORD, REPAIRS
OVER
REPAIRS COMPLETED
Return to RECORD BOARD Foreman's Office
EXAMINE WINDOWS FOR
Broken Lights
Sash Cord which should be renewed
Window Sash which should be repaired
Mark in pencil on each window work to be done thus:—
Broken lights 1 L, 2 L, 3 L, etc. Sash cords to be renewed, S. C. Sash to be repaired, S. R.
Locate windows by counting from either end.
Place check mark on card at the end of the building from which you are counting thus

FIG. 2. WINDOW-INSPECTION CARD, NEW YORK NAVY YARD
(Face of card at right, reverse side at the left.)

mented by daily-report cards submitted by the man actually making the repairs which were shown to be necessary by the examination. The report cards contain definite instructions for the making of the routine repairs and directions regarding tools and material required for the job.

The examinations are made by workmen who have shown special ability for such work. The periods elapsing between inspections naturally vary with the character of the structure or equipment. The cost of making routine repairs has been reduced by the system by cutting down the time lost in locating the places to be repaired, in knowing what materials are needed, and in insuring that this material is on the job.

In developing the present system, it was realized that placing too much clerical labor on foremen will interfere seriously with the supervision that they should give to their work. The workmen themselves have the time to fill in the information required on the cards and can do so readily, with a little instruction, if the language is confined to definite questions which cover all the points on which information is desired. The only clerical labor devolving on the foremen is filling out the instruction cards, and this is more than compensated for by the saving of their time in other ways.

The card shown in Fig. 1 gives the condition of and the repairs needed for the roof covering, gutters, downspouts and skylights, one card being used for each building. The card is supplemented by a white print of the roof plan of the building, which is secured to the card by fasteners. There is a separate plan for each building on such a scale that the entire roof can be shown on a plan the size of the card.

Examination is made from the outside, and the location for repairs is marked on the plan as well as on the roof. Notes are made on the plan and also on the back of it, as may be required, to supplement the card. This examination is made, as previously explained, by a man who is assigned to the routine inspection of structures and equipment. He merely notes on the card and plan the repairs necessary, and then the man who performs the actual repair work has no difficulty and loses no time in finding the place needing repairs.

A rainy-day examination card is provided to supplement the roof-work card and is used for examinations of roofs from the inside, during or after a hard rain.

The card shown in Fig. 2 is used by the workman making routine inspections of window glass, window glass frames,

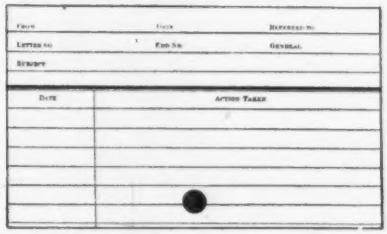


FIG. 3. FOLLOW-UP OR "TICKLER" CARD FOR CORRESPONDENCE

and sash cords, for indicating window glasses or sash cords to be replaced and frames to be repaired. The building diagram has sufficient window space to cover the largest building, one card being used for each side of the building. When the examination card is turned in, the workman who is sent to make the repairs knows just what material and tools are necessary and the location of the window to be repaired.

Another card similar in plan to the roof examination card (Fig. 1) is used to insure the routine cleaning of roof gutters, downspouts and roofs. The work is done by laborers, the turning in of the card denoting that the roof gutters are clean and the downspouts free. The men doing this work do not examine the roof for defects or make any report, this being done by the man assigned to routine inspections.

FILING THE CARDS—All examination cards are kept on a series of record boards in the office of the foreman in charge of building trades. This board is made up of leaves which are hinged on one edge so that all boards fold together against the wall. The faces of two leaves when opened flat are large enough to provide a space for each building in the navy yard. Each space has its building number under which the cards relating to that building are hung for the class of reports in question. Only one kind of examination card is hung on the same board. If all spaces on the board are full, it indicates that all buildings have been examined for the item covered by the examination card in question.

When a workman starts on a job covered by the examination card, he takes the examination card with him and puts in its place a blue "Out" card with his name and the date on which the examination card was removed. All examination cards are 4½x8 in., buff in color and made from extra heavy stock No. 1, commercial grade. The "Out" card is a blank card, 4x6 in., blue in color, and is punched for hanging on the record boards.

ESTIMATE CARD

For miscellaneous work of a routine or simple character, estimates are made by the shop master on an estimate card. This card is made out by the shop superintendent and gives a brief description of the work required with references to plans, memoranda or other data, as may be needed. The bill of material on the reverse side of the card is filled out only when used in making the estimates. It is usually made up in this case by the shop master for quantities as well as prices. This card is 5x8 in., white in color, and of medium heavy stock. It saves a great deal of time and trouble in having all the information in convenient shape on a small card which is far easier to handle than paper.

FOLLOW-UP SYSTEM

The business of the Public Works Department is transmitted in the form of letters, orders, notes, etc., sent to the head of the department and distributed by him to his assistants. To properly trace and at all times keep in touch with the progress being made in caring for this work, a "tickler" system is used. When correspondence is received, the head of department initials it and places

on it the name or initials of the person to whom he wishes it referred. A card (Fig. 3) is then made out and placed in a cabinet on the head of department's desk.

This cabinet has subdivisions for each person to whom correspondence is referred or work assigned, there being in all eight subdivisions. The person to whom the work is charged notes on the card under "date" and "action taken," just what he is doing on that matter from day to day until the matter has been disposed of. Then the card is removed.

This system has three distinct advantages: it prevents correspondence from being pigeon-holed or work assigned being forgotten; it enables the person to whom any work is assigned to keep track of all his work; and third, it enables the department head to see at a glance just how the work which has been assigned to any one of his assistants is progressing. In addition to what might be termed strictly correspondence, memoranda or notes from the head of department to his assistants are entered in the same manner as correspondence; and even when emergency work requires an oral order, where possible a written memoranda of this is made and sent in the usual manner, so that it may be entered properly upon the tickler.

When the work for which a tickler card was made out is completed, or the correspondence filed, the card is filed in a card cabinet, the drawers of the cabinet being arranged to correspond with the subdivisions of the cabinet on the head of department's desk, cards being separated by months.

The organization and systems herein described were gotten up and put into effect by Civil Engineer F. R. Harris, U. S. Navy, Head of Department of Public Works, Navy Yard, New York, and Civil Engineer A. L. Parsons, U. S. Navy, Shop Superintendent.

Filing Methods and Routing in an Engineering Office

By J. C. Trautwine, 3d*

In Engineering News of Oct. 19, 1911, p. 470, J. W. Seaver, Jr., described the methods employed in his office in connection with the filing, etc., of documents for ready reference. The following describes some of the methods followed in our own offices; it illustrates incidentally the requirements of an office devoted largely to literary work.

Roughly speaking, when something is wanted in the average practising engineer's office, it is some *one* thing, some particular item or paper; whereas, in our editorial work, it is usually required to find *all* of the material relating to some *one subject*. It is frequently good practice, as in Mr. Seaver's case, to make use of arbitrary "accession numbers," with a separate index; but for our work we find it preferable to file by a "classification," each article being placed at once in its proper place, according to its subject.

Classification—On account of differences in size and shape between different articles, we must still have separate collections for "Books," for "Card Index," for "Vertical File" (correspondence, etc.), and for "Drawings." However, each of these collections (including 4500 books, and 50,000 cards, with 3500 guides), is arranged under one and the same (Dewey) classification, so that any given subject number applies to the same subject in all the collections.

In conjunction with the Dewey system (for which we have provided many necessary additional subdivisions) we maintain a selected alphabetical index, in card form, covering all subjects pertaining to our work, so that we always have a complete guide to our classification.

Of course, on those few occasions when we wish to locate an individual item, our system is usually at a disadvantage as compared with one employing arbitrary accession numbers, for a large number of our papers may all bear the same Dewey number; but it seems better to do this than to be obliged to ascertain perhaps a half dozen or a hundred or more arbitrary accession numbers and then locate each of the papers separately, in the many cases where we must find all the information we may have filed on any one subject.

Routing and Routine Sheets

For the reviewing and indexing of periodicals we used until recently a method similar to that of Mr. Seaver. At least, each periodical went bodily from one person to the next, according to a generally recognized routine, and remained with each person until he had completed his step in the routine. With pressure of more urgent matters, however, many of the periodicals remained out of the files for months at a time, so that, when a periodical was wanted, about half of the office force had to be interrupted and asked about it before it could be found; and as our force grew the matter became a glaring case of "*in*efficiency engineering."

This difficulty has been overcome by a method of "routine sheets," which appears to be of very general application, and which we first employed in handling our manuscripts and proofs (which, for reliable work, must receive numerous treatments at various hands, in their appointed order, and without fail). Under our present method each periodical or paper normally remains in its proper place in the files, and a printed or typewritten "routine sheet" is provided, on which is a list, in proper standard order, of the steps to be taken, each step being marked with the initials of the person by whom it is to be taken. This sheet goes its way from one worker to another, while the paper itself is called for only when there is opportunity to work at it. Each worker records, also, on the sheet, the dates of starting and finishing the step assigned him. We thus have a complete record showing when and by whom each step was taken, so that the cause of an error or of other defective work may be traced back to its originator, and so that undue delays may come to notice. This is especially valuable in the case of proofs. A sample of the "Periodical Routine Sheet" is reproduced below.

PERIODICAL ROUTINE SHEET
Name of Periodical, Eng. News.
Date of Periodical, 1911, Oct. 5.

1911, Oct. 5.	T3 review thoroughly.	1911, Oct. 15.
1911, Oct. 15.	80, Find P-B ad, if any, and trans. it to B8.	1911, Oct. 16
1911, Oct. 16.	T2 review comments.	1911, Oct. 26.
1911, Oct. 26.	E1 review comments. B8 Index. B8 Review for bibliography. H6 Review for prices. 80, Remove ads except from small periodicals. File periodical and destroy this sheet. (B)	

On receipt of this sheet, place it in your (B) pigeon hole.
When ready to do the work, get periodical.
Mark this sheet (as it is done on MS. and Proof Routine Sheet).
When work is finished,
Place this sheet in Trans.
Place periodical in File.

It will be seen that the name and date of the periodical are filled in at the top. Each line that follows represents some particular work to be done with that periodical. The dates on the left are those of receiving the routine sheets by the individuals named (by means of abbreviations) at the beginnings of the lines; while the dates on the right are those of finishing the several steps of the work. As the work of each line is completed, that line is underscored.

Thus, on the sheet herewith, we find that "T3" received the sheet on Oct. 5, and completed his work of reviewing the periodical named on Oct. 15; that "80" (any one of the office boys) found our advertisement and removed it the next day, that on Oct. 26, "T2" completed his review of the pages marked, and that it has since been awaiting review by "E1." The indexing, by "B8," and the other steps, will then be taken up in their turn.

This use of routine sheets (while apparently a bit of "red tape") is found to be very satisfactory and is delightfully flexible. Where so desired, the "routine" may be extended, by inserting additional lines, or it may be abbreviated by canceling, although "short-cuts" are strictly forbidden except by permission of the proper authority. It will be seen that it is entirely practicable to overlap or duplicate the reviewing where desired, or to

*Of Trautwine Co., 257 S. 4th St., Philadelphia, Penn.

avoid repetition or even initial reviewing of any one page or pages by any one. All this may be done without confusion, and the record remains to show what has been done and what omitted.

In addition, we have, for periodicals, letters, books, etc., a standard form of "Out Card," to be used, not only when books, etc., are removed from the office, but also when they are removed from the book shelves. Anyone removing a book from its place enters his initials and the date upon the out card, which then remains in the file in the place of the article removed. If there were only two or three workers in the office, these cards would fall under the head of "red tape," but, with a larger force (some of them transients) these cards quite pay for themselves and for the labor (usually that of the office boys) of maintaining them.

Kutter and Bazin Formulas: Notes on the Coefficient of Roughness

By Ernest W. Schoder*

In the use of the Kutter formula in designing open channels the engineer meets (whether or not he recognizes it in precisely this form) the question: If my estimate as to the value of the coefficient of roughness n is wrong or uncertain by a certain percentage, what per cent. of error or uncertainty will there be in my estimate of the discharge for a fixed slope, or of the required slope for a desired discharge.

Simple and important though this question is, the direct answer, and a very simple one, is not to be found in any treatise on hydraulics, as far as the writer knows. Neither is there to be found, let alone emphasized, a direct statement of a simple relation between the value of the coefficient of roughness and the velocity or the slope.

If the engineer wants to know the effect of certain variations in n he makes several calculations, usually by diagrams or tables, and compares the results. This is easy, but it leaves no definite general idea in mind for future use. In fact, the common opinion seems to be that the value of n is involved in a complex manner in the velocity coefficient, C, in $V = C\sqrt{Rs}$. This seems to have carried with it the idea that n and V or n and s are intricately, and not simply, connected. For practical purposes the reverse is true.

The following relations hold for the Kutter formula. Other things being equal, (1) the slope s varies as n^2, almost exactly for all values of the hydraulic radius R greater than 1 ft.; (2) the velocity V varies inversely as n, exactly for $R =$ about 2 ft. and approximately for other values.

Corresponding to these relations we may state that a certain per cent. of uncertainty in the value of the coefficient n produces: (A) double that per cent. of uncertainty in the slope necessary for a fixed discharge, and (B) the same per cent. of uncertainty, but in opposite direction, in the velocity or discharge resulting from a fixed slope, if the slope is assumed to be greater than 0.0001.

As an illustration of the convenience of this knowledge, suppose that in designing a canal it is uncertain what value in the range between 0.017 and 0.020 to choose for n. This is an uncertainty of about 8% either way from the mean value, and represents a probable occurrence in practice. We can state at once that the uncertainty in discharge, as caused by ignorance concerning n, will be about 8%, and in required slope about 16%.

The graphical representation establishing these relations is shown in the accompanying logarithmic diagram, Fig. 1. The roughness corresponding to $n = 0.015$, is taken as the standard for comparison. Any other value could have been taken.

This diagram may be used also to adjust results for some one degree of roughness to any other degree.

The Bazin formula, although simpler in form and with fewer categories of roughness, has not such simple relations between its roughness coefficient and values of V or s. The diagram, Fig. 2, shows this clearly. Bazin's category IIIa is taken as the standard for comparison. The form of the formula used is the one in which it most nearly corresponds to Kutter's, viz.:

$$V = \frac{158}{1 + \frac{N}{\sqrt{R}}}\sqrt{Rs}, \text{ (ft. sec. units.)}$$

This is also the simplest form. The value of the roughness coefficient N is 1.81 times Bazin's γ, and is from 11 to 90 times Kutter's n, where the correspondence of the formulas would lead one to expect N always $= 42.6\ n$. This is the recognized peculiarity of Bazin's formula expressed numerically. In all other respects it closely resembles Kutter's as simplified for the usually occurring slopes. Since this is not apparent to many, the comparison is given herewith:

Kutter's formula is

$$V = \frac{(41.6 + 0.0028/s) + 1.811/n}{1 + (41.6 + 0.0028/s)\, n/\sqrt{R}}\sqrt{Rs}$$

If we give weight to Bazin's opinion that slope has no influence on C, we may place the fraction $0.0028/s = 1$. If, also, we decide to choose different numerical values than did Kutter for the various categories of roughness, we may replace the fraction $1.811/n$ by 115; i.e., calling the value of n in this term a medium value, 0.0157. This gives for the complicated fraction the simpler one,

$$\frac{158}{1 + 42.6\, n/\sqrt{R}},$$

in which n is to have values smaller than the Kutter values for smooth channels and larger for rough channels.

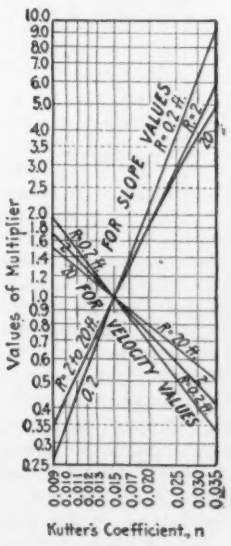


Fig. 1

Diagram of Relation between Coefficient n of Kutter's Formula and the Corresponding Discharge and Slope

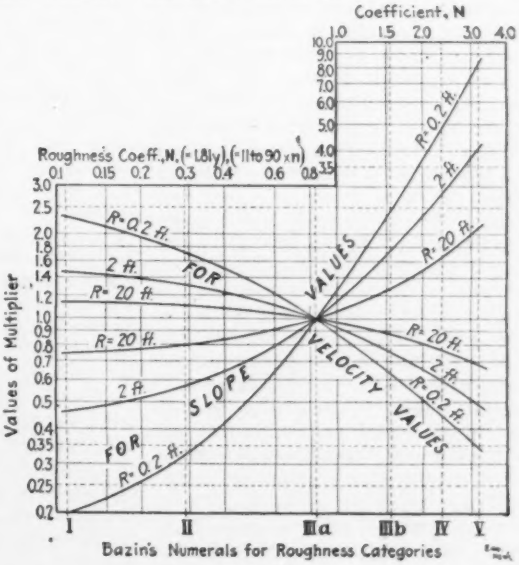


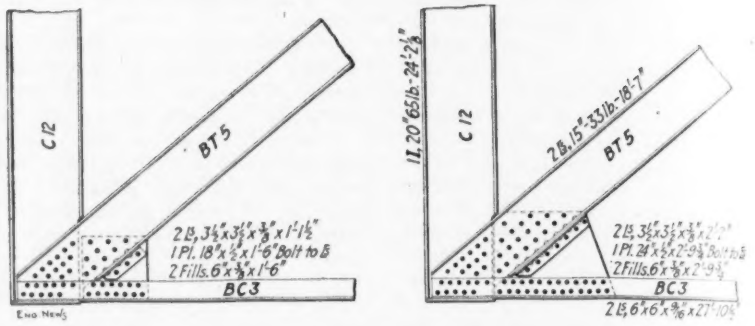
Fig. 2

Diagram of Relation between Coefficient N of Bazin's Formula and the Corresponding Discharge and Slope

*In charge of the Hydraulic Laboratory, Cornell University, Ithaca, N. Y.

The writer, while not desiring to champion Kutter's formula as the superior one, would point out the desirability of giving such numerical values to the coefficient of roughness as to have a simple relation between the retarding influence and the effect. Ganguillet and Kutter have done this, although in other respects their formula is capable of improvement.

It is not intended here to intimate that either of the formulas above discussed is preferable to the formulas with odd decimal exponents, which have been proposed, but have not become widely established as yet.



FIGS. 1 AND 2. ORIGINAL AND REVISED DETAILS OF END-POST CONNECTION OF AN OREBIN TRUSS

Some Puzzles in Steelwork Details

BY HART VANCE*

The sketches herewith illustrate two cases of curious developments in the drafting room:

Fig. 1 is a detail of a heavy truss designed for the support of ore bins pertaining to one of the plants of a great smelting and refining company. The steel for several such plants was fabricated by a company in one of whose many drafting-rooms I was employed, and this detail appeared in shop drawings which were sent me from another of those rooms in order that I might adapt what was available of the work already done to the requirements of the plant for which I was preparing drawings. The changes requisite for such adaptation, in the case of trusses of this type, were very slight and did not touch the detail shown, but I got from inspection an impression of inadequacy in this joint and examined it more closely.

I found that the connection between BT5 and BC3 required 36 rivets, while it was detailed with only 23, 12 in the gusset plate and 11 in the direct connection. The discrepancy was remarkable in view of the stress sheet, which showed plainly the necessity for 35+, and studying it further, I made the curious discovery that the web of the I-beam post C12 (a post in the retaining wall of the bin) had undoubtedly been regarded as forming an additional connection between BT5 and BC3, through the 12 rivets joining it only with BT5 and the 11 passing through all three members, though the latter were, of course, counted also in the direct connection.

It was, perhaps, more curious that, even to make up the total of 35 rivets, the twelfth of those joining C12 only with BT5 had been reckoned as countering the thirteenth joining BC3 with the plate.

The blueprints I received bore the signatures of detailer and checker, and I learned that 20 trusses, in each of which the deficient connection occurred twice, were in process of fabrication.

I had a tracing made of the adapted trusses, without change of the connection as shown in Fig. 1, and submitted it to one of our best checkers as an original product of our office. He discovered the need of one additional rivet—that there should be 36 instead of 35—but did not detect the lack of the dozen.

Fig. 2 shows the revised version of the connection eventually used in my details.*

Fig. 3 is a sketch of a coaling bridge the design drawings for which I recntly had occasion to examine, when they were sent to the bridge company subcontracting to fabricate the steel. The structure was designed by the contractors, a well-known firm of engineers, and the material was specified in detail. I noticed that the vertical, which I have marked *a* on the sketch, was billed "2 ⊲s 3x2x¼ in." and I found, upon examination, that many other members in compression were correspondingly slight. I called the attention of the contractors' "Assistant Chief Engineer"—who seemed to be principal designer of the bridge—to the fact that *l/r* in the case of the member *a* would be about 200, and in several other cases nearly as much, but he seemed not to catch the relevance of my comment, and, when I suggested that collapse of the members was not unlikely, he replied nonchalantly that he thought they would be stiff enough. Revised sheets appeared shortly afterward, however, and showed changes especially where I had noted deficiency; the *a* member, for instance, had become a "star strut" of two angles 2½x2½x¼ in., and it was detailed accordingly.

Meeting the Chief Engineer of the contracting firm, I chaffed him about treating accepted notions concerning *l/r* as superstitions. He thought I must be mistaken as to the instance, but he subsequently told me he had ordered the substitution of 3½x3½-in. angles for all smaller sections in all struts. Even with this improvement, the value of *l/r* exceeds the maximum (110) allowed by the specifications which were part of this contract, if not the maximum in any good practice.

There were many other astonishing errors in the design of this bridge. For instance, all the diagonal members in the boom as shown were put in at my suggestion after the boom had been detailed in accordance with the design. The opinion of the "Assistant Chief Engineer" that the 18-in. horizontal girders made it strong enough without diagonals was overcome only by an illustrated demonstration that the torsional moment in the uprights of the yokes from wind, even at 20 lb. per sq.ft., would exceed their resistance at 16,000 lb. per sq.in. by not less than 4 to 1.

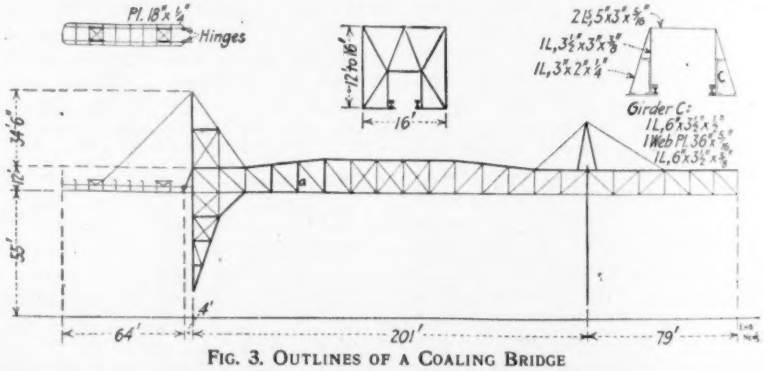


FIG. 3. OUTLINES OF A COALING BRIDGE

*534 Oakdale Ave., Chicago, Ill.

*Nothing is said of torsion on the rivet groups in the gussets of both Fig. 1 and Fig. 2, which would reduce the efficiency of these rivets.—Ed.

Reproducing and Filing Township Plans

By Donald Davis*

An improved method of reproducing and filing township plats which I use here may be of some interest, especially to those in Western states who have much to do with tracings and filings of Government township plans. The method formerly employed in the Idaho State Land Department was to make a tracing of the plan giving only the lot areas and principal streams, or about 30% of the information inscribed on the plan. These tracings were then transferred to plans printed on cloth and were transcribed apparently by sketching. Townships covering the entire state are bound in eight volumes.

The method I now employ is to trace the township plan the same as formerly, but giving all information. Then a print is made on cloth by the negative and positive or Van Dyke method. This insures a true and accurate reproduction from the tracing, and this reproduction is then bound as before. As closely as could be estimated the former method cost about $3 per plan, and by the latter has averaged about 75c. per plan. This cost I date from the tracing. I hope in the near future to mount each plan on a card and file in a portfolio section like that manufactured by the Yawman-Erbe Co.

The tracings are filed in a portfolio section in envelopes. These are made 18x 24 in. and hold about 20 or 25 tracings each. The drawers will contain about 40 envelopes. Each envelope is labeled by a raised tag placed so that it can be read at a glance. Each succeeding tag is placed a little to one side of the one preceding, and all making a line diagonally across the drawer. The great difficulty in filing tracings is their lack of stability. This envelope system of filing I find permits of ready reference and protection from creasing.

*Office of State Board of Land Commissioners, Boise, Idaho.

Work and Prospects of the Logging Engineer*

I have received a number of letters from prospective foresters asking for information as to what opportunities were offered a technical man with private logging and timber companies. In the Pacific Northwest we are not yet at that stage of development in which our timbermen and millowners can see the end of their resources in the near future and are sufficiently jarred by the prospect into taking steps to provide for a perpetual timber yield. As a matter of fact, we cannot even approximately utilize our present waste. We are simply in the position of Wisconsin and Minnesota in the 90's, with the important exception that our business men are wiser from past experience, and most of them more than willing to take any necessary steps to avoid the serious consequences of an exhaustion of our timber supply, provided they can get together, as to ways and means, and can be shown that dollars invested now will at least earn their 5% a year.

That we are progressing along the right lines is shown by our forest-fire laws and their effective enforcement, and by the work done by E. T. Allen, forester for the combined timber and fire associations of the northwestern states. So far this work has been mostly educational and tending toward the enactment of such laws as will enable the work of providing for future generations to be put on a sound and profitable basis.

It is easy for the young forester, fresh from his studies of the latest and most advanced methods, to make the mistake of condemning local methods before fully understanding the underlying principles and conditions which may justify seemingly incorrect and wasteful ways of going at things. Let him first ask himself "Why," and after thoroughly threshing it out he will be in a better position to suggest changes.

First and foremost, you must specialize on the importance of the logging railway. The railway is the main artery of the modern logging plant, and, aside from the timber itself, it is the most important consideration in planning for a logging operation. Under this head comes topography, taken in connection with a thorough reconnaissance of the entire tract. You will have very little use for triangulation or traverse methods in this first preliminary examination. The general mapping will be done by pacing and the use of the aneroid, with checks on the section and quarter-section corners. All section lines should be run out and reblazed, and the mapping done by the contour method, using from 20 to 50 ft. contours, depending on the relief of the country and the accuracy required.

Once you get your country mapped you have a splendid basis from which to work on the preliminary reconnaissance for the railway. It usually pays well to go over as closely as possible the route to be taken by the road and get thoroughly familiar with the topographic details that will control it. For instance, suppose, after you have gone a mile or so, following a tentative grade of 2%, you will find that by increasing your grade 0.5% you can gain a bench which will give much lighter construction for a considerable distance. This will be a vital control in the laying out of the road, either necessitating an increase in grade, or a new starting point for your climb. In general, the whole line must be laid out in reference to the points of chief difficulty or where the greatest saving can be made in cost of construction without impairing the value of the road as an outlet for the timber. The latter point is one which must never be lost sight of.

You must thoroughly understand logging to successfully construct logging railways. It is just here that the contracting surveyor or engineer falls down. His ideal is the road itself. Yours must be the logging operation as a whole. Your cost must be governed by the amount of timber to come over the road and the probable expense of logging it. When possible, you will want to limit to a 16° curve and a 3% grade on main lines, but quite often you will have to depart from these limits and will be entirely justified in doing so.

Having threshed out the main line, you are ready for the preliminary survey. In this section the day when railways could be laid out by eye, and with curves run in with a tape, is past. It is real railway engineering; a transit should be used on main lines, while a good compass and hand level will serve very well for the spurs. You must be able to give a pretty close estimate on each mile of proposed construction from cross-sections of the excavations and fills, including drains, culverts, trestles, bridges and equipment. We have a number of logging bridges over 100 ft. high and from 600 to 1000 ft. long, and every year as the logging gets further back into the foothills the longer and more permanent are the main lines of the logging railways.

You may find several preliminary "fly lines" necessary in the very difficult places before the final location can be determined. The preliminary lines are plotted in the office, usually by latitudes and departures, and from cross-section topography the final location can be sketched in, subject to further changes on the ground if necessary. The spurs are laid out much in the same manner, economy, however, being the main consideration. You can afford to haul over a 6% grade and 32° curve for a few months on spurs where two or three loads can be switched out at a time. In most instances a light locomotive, geared or direct-connected, is kept especially for switching from the landings on the spurs to the main-line sidetrack.

Then there is the maintenance to be supervised, and a close watch kept on construction. At the end of each year you will have a detailed report on the railway work, cost of engineering, construction and maintenance, cost per 1000 ft. for timber coming out over each spur and over the main line.

Another duty will be the laying out of

*From a paper on "The Logging Engineer in the Pacific Northwest," in the June number of "American Forestry"; American Forestry Association, Washington, D. C.

pole and skid roads when necessary. Together with the spur work this should be done with the coöperation and help of the logging foreman. Your idea must always be to facilitate his work in the actual logging operation as much as possible, and you must be aware of his future plans, governing your work accordingly.

As a general rule you will coöperate with the foreman and superintendent in selecting camp sites and in locating landings. At the landing there should be enough grade toward the main track to drop the loaded cars by gravity, and yet not too much grade, as that would make this proceeding dangerous. It is very easy to let a loaded car get away on a grade, and even where proper precautions are taken as to safety switches and derailing devices a great deal of damage may be done by such a runaway.

Next to the purely engineering side of your work will come fire protection. It is quite true that the greater part of this country is patrolled more or less thoroughly by one of the fire-protective associations. But in nearly every instance the effectiveness of the patrol depends almost entirely on the coöperation of the logging companies. And nine times out of ten the actual handling of any fire on your lands will devolve on you. Hence, the necessity of adequate preventive measures, such as burning slash, clearing up the railway right-of-way, constructing fire trails, and organizing the logging force so that at a moment's notice it may be converted into an efficient fire-fighting body with proper equipment ready for use. In this one particular alone the logging companies of this section have perhaps more room for improvement than in any other branch of their organization. I sincerely believe that enough property, camps, logs, donkey sleds, etc., together with the often misplaced energies of a typical logging crew fighting fire, would fully meet the expense of such an organization for fire protection within a short period of years, not to mention the practical insurance against loss from fire that such a system would constitute.

The timber end of the work is by no means unimportant. There will be quite a large amount of cruising and scaling to do, and I wish to state most emphatically that a man new to this country needs several years' experience in timber before he can constitute himself a competent judge. Different localities have their own characteristics: in mixture of species, variations of growth conditions, marketability and special conditions.

Any question of subdivision of sections or of trespass will come under your duties. The accurate scaling of trespass from the stumps is quite an art of itself, and many of the larger timber holders employ men who give practically their whole time to watching for trespass.

At the close of each year's work, in connection with the railway report, would be a report on the year's logging, showing the area cut by each camp, the average yield per acre, and the average cost of logging per 1000 ft. by the month, also the cost of timber left on fractional forties. This would give the owners of the company an idea of how their cruises were panning out and how much timber was still left tributary to the camps in their present location.

Another problem is the final utilization of the logged-over lands. Will it pay to re-forest? If so, what method will be best suited to the land in question? If not, what will it cost to clear and subdivide into small farms? Can you successfully clear by the char-pit method, or will it have to be done with dynamite and a donkey engine? In short, the question of our logged-off lands is as important to this section of the country as is irrigation to the arid lands of the West or the drainage of swamp lands to the South, and the man who can present and work out a satisfactory solution to this problem is going to be one of the big men of this section. And it is by no means an unsolvable question.

I have laid out townsite additions and drafted plans for a hospital, estimated power generated by our mountain streams and surveyed mining claims. In fact, the diversity of the work and the continual game of working out new problems (for no two logging propositions require the same treatment) is one of the biggest attractions in this sort of work. And it takes a good man and a versatile man to succeed. There is not a large logging company in the country that does not need such a man. They may not all realize their need, but it is there just the same. And there is no better training in the world for a first-class woods superintendent, and first-class woods superintendents are not readily picked up these days. Make yourself valuable enough to your company to demand an interest, or else have the ability and knowledge to put in with capital in the development of an operation of your own.

This does not sound much like forestry, does it? But after all, what is forestry but scientific management and operation of timber lands? And if State laws and local market conditions make it impossible to either hold your timber or to utilize it completely, is it not good forestry to operate to the best possible advantage under present conditions and in the meantime try to better the conditions? Of course we can better our methods now, and year by year in the future, but we cannot do it all at once, and the more technical men who become associated with the actual logging and manufacture of timber, who will work toward the end of practical conservation, the sooner we are going to get such conservation. I should not be surprised to see large companies in this Western country who, operating under wise tax and fire-protection laws, will own tracts large enough to give their mills a perpetual supply of logs. And when that time comes, it will be the forester working from the inside of the actual operation who will know best what may and may not be attempted.

But it means work and more than that—drudgery, especially to a college graduate, whose pride is going to be hurt more than once while he is doing subordinate work, often under men who, lacking education, affect to look upon any one who has been a "college boy" as no good when it comes to real work. You will often find yourself regarded as a failure simply because you are working up in a big business. I thoroughly believe that this is one business that has to be learned by actually getting in and working at the various subordinate jobs that go to make up the whole of a really big business.

There will be many times when you will ask yourself whether or not you have made a mistake after all in taking up private rather than government or state work. You see your classmates going ahead more rapidly at the start than you can hope to do. They receive more money to start with and are promoted more rapidly the first year or so. And they are doing more technical work, are using their education, while you are way back in the primary grade again. This is the hardest rub of all, and I believe it influences more men to go into the government service than any other one thing. But while ten years may seem a long time to a young fellow, to a big corporation (training men for the work of a lifetime) it is but a short and necessary period of preparation. And you need not expect to have to put in ten years of drudgery.

Graphical Solutions of Astronomical Problems

By R. Stanley Swinton*

The accompanying illustration shows a graphical method of solving problems relating to the location of the sun or of fixed stars at any given time. The accuracy attained is readily within a half minute of time, or 0° 7′ of arc. The method is useful in teaching practical astronomy, in arranging fenestration of buildings, in pointing a heliostat, or in setting an instrument so that it shall be pointed at a certain star at a certain time.

In the determination of azimuth with a transit we are given the latitude, declination and altitude. The method of procedure is as follows: Place a protractor on line *ON*, Fig. 1, with its center at *O* and lay off the latitude, zenith, equator, altitude and declination for noon at Greenwich. (This is sufficiently accurate).

*University of the Philippines, Manila, P. I.

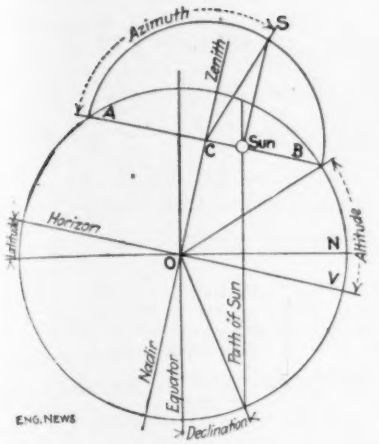


FIG. 1

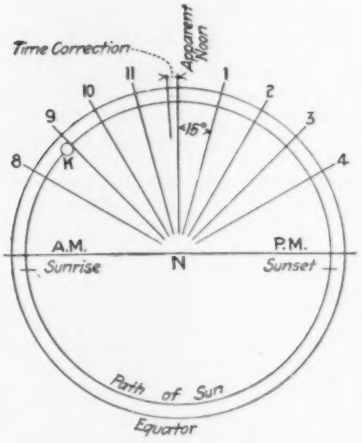


FIG. 2

METHOD OF SOLVING ASTRONOMICAL PROBLEMS BY GRAPHICS (SOUTHERN HEMISPHERE)

Draw *AB* parallel to the horizon, and draw the path of the sun parallel to the equator. The intersection of these lines represents the position of the sun, with reference to the local meridian, at noon, at Greenwich. If *AB* be considered a plane its revolved position will be *ASB*, with center at *C*, and the revolved position of the sun will be *S*. Angle *ACS* is the azimuth of the sun if it be an afternoon observation, or 360° — *ACS* is the azimuth if it be a forenoon observation.

If it be required to find the altitude and azimuth of the sun at a given time, the latitude, declination, and civil time of apparent noon should be known. The time correction may involve the longitude, mean and local time corrections, but can be avoided by starting with the sunrise or sunset time as given in a local almanac.

The method of procedure is as follows: Set the protractor on *ON* with its center at *O* and lay off the latitude, equator, zenith, and declination. Draw the path of the sun parallel to the equator and project it as a circle in Fig. 2. The intersection of the lines "Path of Sun" and "Horizon" is the position of the sun at sunrise or sunset and is projected in Fig. 2, as shown.

Lay off the angle *K-N-Sunrise* equal to the time between sunrise and the given time. *K* is the position of the sun and is projected to Fig. 1 as "Sun." Draw *AB* through the sun parallel to the horizon. *BOV* is the altitude of the sun and the azimuth is found as explained in the first problem.

Other problems possible of solution are: given time, latitude and altitude to find declination and azimuth; or given declination, altitude and azimuth to find latitude and apparent time. In the latter case the position of the sun is at the intersection of its path and a circle having its center at *O* and its radius the hypothenuse of a triangle with legs *CO* and *C-Sun; CO* is known, since the length of the chord *AB* is determined by the altitude, and *C-Sun* is known because the azimuth is known, as shown in Fig. 1.

Having made a graphical solution it is a simple matter to apply trigonometric formulas to the original data and arrive at as accurate results as may be desired with a clear understanding of the work.

Notes

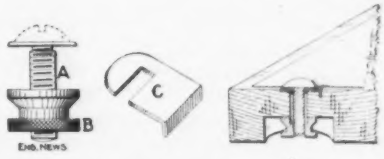
Low-Cost Testing-Machines are further referred to by A. O. Anderson, Ames, Iowa, who believes that tests in regular fieldwork are very valuable. The description of two simple testing-machines for concrete beams and slabs by E. McCullough (Engineering News, July 25, 1912, p. 161) leads Mr. Anderson to say that results of tests made with Mr. McCullough's apparatus should be published and a set of average values for 4x4- or 3x3-in. plain concrete beams of various mixtures deduced, so that there will be a standard of comparison with future tests.

The Ames pipe-testing machine is recommended by Mr. Anderson as well suited for transverse tests of beams besides tests of tile or concrete pipe. This machine was described in Engineering News, May 18, 1911, p. 609; blueprints can be secured upon application to the Engineering Experiment Station at Ames, Iowa. A light pail hung on the end of the scale beam may be used to keep the beam balanced by running water into the pail. The factor of safety used in designing standard platform scales is so large that the scales may be overloaded to twice their rated capacity without danger; Mr. Anderson has applied loads over 3000 lb. to scales rated at 1000 lb., in testing drains and sewer pipes. In such cases, however, care must be taken that the recoil when the test-piece breaks does not cause permanent injury to the scale. He also states:

The neglect to make simple tests is frequently responsible for bad jobs of concrete work, and since such simple apparatus is all that is necessary to make tests yielding reliable data concerning the quality of the concrete used more attention to these matters will be given by engineers and contractors in the future. In making concrete pipe, tests of this character are very valuable since the earth pressure on pipe in the trench causes stresses very similar to the stresses in the beam when tested transversely.

No Thumb Tacks are Required with the Heyl improved drawing board. The paper is held to the board (firmly and securely, it is claimed) by two spring clamps. The clamps are built into the board near one of the long sides and are intended to catch the upper edge of the sheet. The clamps are designed for a minimum projection above the board surface and can be instantly released by pressure from below. This board is being put on the market by Williams, Brown & Earl, Inc., 918 Chestnut St., Philadelphia, Penn., in four sizes priced at from $1.50 to $2.

A Substitute for Thumb Tacks—The device shown in the accompanying illustration is proposed by Mr. George Wetmore Colles, 404 Alhambra Bldg., Milwaukee, Wis., who states that he has been using the scheme for some time past and finds it a great improvement on the thumb-tack method of holding drawings. The device consists of three parts: The screw A with a broad flat head, the thumb nut B, and the anchor plate C. The anchor plate is simply a small piece of sheet brass, say No. 20, with a flange turned down at one end and an oblong slot cut in the center as shown. The screw has two flats filed on opposite sides of the threaded portion close to the head and the slot in the anchor plate is made to fit this flat part of the screw. The device is applied in a hole bored through the drawing board and counterbored below to give a recess for the thumb nut. The anchor plate should be embedded in the wood of the drawing



SCREW CLAMPS TO REPLACE THUMB TACKS

board by striking it with a heavy hammer so as to bring it flush with the surface.

Mr. Colles states that only two screws are necessary for ordinary drawing paper, and unless a standard size of sheet is used it is not practical to use more than three of the screws, the fourth corner of the sheet being held by a thumb tack if necessary. By using these devices properly aligned along two edges of the sheet the paper can be squard on the board by simply abutting its edges against the shanks of the screws. Mr. Colles claims that the heads of the screws can be filed so thin that they will not project as much as those of thumb tacks. Other advantages claimed are the doing away with tack holes in the drawing paper and board and the fastening of the paper beyond possibility of slipping.

Duplicating Field Note-Books—P. A. Kolesch, of Kolesch & Co., New York City, writes as follows:

On going over your May 23 issue the article on "Loose-Leaf Surveyors' Note-Books" interested the writer. It has occurred to him that perhaps it would be valuable information to your readers to know that there is a duplicating loose-leaf field book on the market, published

by Geo. L. Kopp & Co., Pittsburgh, Penn. This book is 4½x7½ in. and is ruled like the regular surveyors' field book.

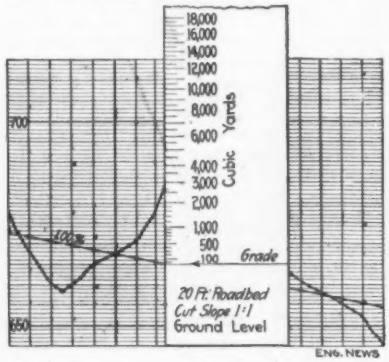
It is interleaved with yellow sheets so that carbon copies can be made of the original field notes. The sheets upon which the notes are made are perforated so that they can be torn out of the book, and the day's work sent to the office for plotting.

The carbon copy which is permanently bound in the book serves the field force with a memorandum of the work done. With this outfit there is supplied a loose-leaf binder (Unique Binder), in which the originals that are torn out of the book are bound.

The books are being used by several railroads and the Bureau of Sewers, Queens Borough, New York City, where they have proved very satisfactory.

Handy Scales for Estimating Earthwork from center line profiles are described by C. A. James, Assistant Engineer, Lehigh Valley R.R., White Haven, Penn., in a booklet of earthwork diagrams recently published by him.

The accompanying illustration shows one of these scales and the manner in which it is used. The slips are made similarly to those described by C. P. Howard in Engineering News of Sept. 13, 1906, p. 268.



HANDY SCALE FOR ESTIMATING EARTHWORK

However, instead of copying on a slip of profile paper the cubic yards per 100-ft. station for each foot of cut or fill, Mr. James suggests graduating the slips at even tens, hundreds and thousands of cubic yards per 100-ft. station to the same vertical scale as the profile.

The scales are made in sets for different cut or fill slopes, for level sections and for sections having different ground surface slopes. The booklet above referred to is designed to facilitate such computations as are necessary to graduate the scales.

Testing Asphalt Pavements—George W. Bates, Deputy City Engineer, of Lincoln, Neb., sends us the following data:

In laying sheet asphalt pavement with sands from new supplies, it is difficult to foresee the behavior of the pavement until it has been subjected to traffic for some time. Sands of similar grading produce very different results on account of the variation of the shape and smoothness of the grains.

A method of testing a new pavement which can be carried out as soon as the artificial heat of the mixture is gone has been tried as follows:

A sufficient layer of the asphalt was cut off to remove the top crust and then the depth of penetration of a 1-lb. Gilmore needle in 10 sec. was determined. Tests were made on pavements laid from one to eight years, as well as those not yet open to traffic.

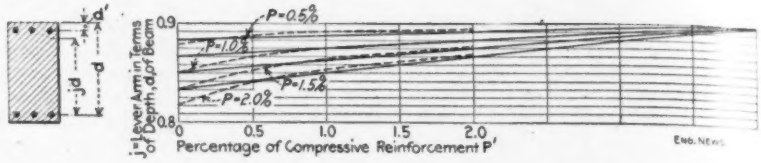


FIG. 1 FIG. 2. DIAGRAM SHOWING EXACT AND APPROXIMATE CURVES FOR LEVER ARM j IN TERMS OF DEPTH d FOR BEAMS DOUBLY REINFORCED $\frac{d'}{d} = 0.1$

Those pavements whose wearing qualities and freedom from cracks have been found to be excellent showed a penetration of from ⅝ to 1 in. in 10 sec. Those where penetration was less than ¼ in. in 10 sec. have been found to be too hard for best results. On one pavement the needle penetrated 1 in. in 5 sec. This pavement has worn well, but is softer than necessary.

The above tests were made June 27, 1912, between 3 and 4 p.m., on a clear day with the official U. S. Weather Bureau thermometer registering 96° F.

So far no attempt has been made to fix a standard, the method having been used only as a comparative test with pavements of known good composition and wearing qualities, as shown by use.

The writer would like to hear of any other tests made along these lines.

A Mechanical Wolf Scarer for the protection of herds of sheep has been devised by E. C. Winchester, of Thermopolis, Wyo. As described in the "Scientific American," it consists of an automatic gun which can be adjusted to fire a blank cartridge at intervals of 30, 40 or 60 minutes as desired—depending presumably upon the rapacity of the wolves. It is provided moreover with a bullseye lantern which is revolved by clockwork at about 1 r.p.m. The complete mechanism weighs 25 lb. and is mounted in a dustproof case on four adjustable legs. It is claimed to have given good results in keeping the sheep together at night and keeping off wild animals.

Patching a Water Pipe by Welding was done last spring at Schenectady, N. Y., under unusual conditions, according to C. C. Anthony, of Union College, Schenectady. A 36-in. riveted steel main leading from the pumping station to the city developed a leak where the pipe passes under a 45-ft. embankment of the Delaware & Hudson Ry. Settling of the bank then caused a riveted joint of the main to tear out, letting out a thin sheet of water which rapidly scoured out a large opening.

After getting at the point of break by a trench, about 8 weeks time was used up in experimenting with methods of repairing the pipe. During this time the city was exposed to serious fire danger, as the water supply depended on a 24-in. main, which was too small to give adequate fire-protection.

The opening was found to be too large for calking. The plan of putting a sleeve over the joint and lead the ends was given up when it appeared that the joint was torn out enough to make it probable that a new break would occur when the trench was refilled. Taking out the two lengths of pipe adjacent to the broken joint would have entailed a very great expense for piling and excavation, the sand of the hillside flowing in constantly. The final solution of the difficulty was that a portable oxyacetylene plant of the General Electric Co. was brought over, and two men in four hours welded and built up the joint, at an actual expense of $35.

Formula for Lever Arm of Doubly Reinforced-Concrete Beams

BY ARTHUR G. HAYDEN*

The following empirical formula for determining the lever arm of the resisting couple in concrete beams with double reinforcement has been found useful as a time saver in place of the cumbersome exact formulas, in deriving values of the lever arm for other conditions than those assumed for the curves usually given in textbooks. The formula is as follows:

$$j = 0.93 + 2\,p' + 100\,pp' - 4\,p - 0.1\,\frac{d'}{d} - 20\,p'\,\frac{d'}{d} \qquad (1)$$

where (see Fig. 1)

p = Percentage of tensile reinforcement expressed decimally;

p' = Percentage of compressive reinforcement, expressed decimally;

d' = Distance of the compressive reinforcement from the compressive face of beam;

d = Distance of the tensile reinforcement from the compressive face of the beam;

jd = Arm of resisting couple.

The compression in the concrete is assumed to follow the linear law, and tension in concrete is neglected.

The formula is approximate but liable to an error not exceeding 1½% for all proportions of reinforcement (tensile or compressive) between ½% and 2%, while for ordinary cases the error is inappreciable.

The exact formula for the arm of the resisting couple is

$$jd = \left[1 - \frac{k^3 + \frac{d'}{d}\,6\,n\,p'\left(k - \frac{d'}{d}\right)}{3k^2 + 6\,n\,p'\left(k - \frac{d'}{d}\right)}\right] d$$

in which k must be first determined by the formula

$$k = \sqrt{2\,n\left(p + p'\,\frac{d'}{d}\right) + n^2\,(p + p')^2} - n\,(p + p')$$

*Bridge Designer, N. Y. State Barge Canal Office, Albany, N. Y.

The advantage of the approximate formula is at once apparent, its solution requiring approximately 30 sec., as against about 3½ or 4 min. by the exact method.

Curves are usually given in textbooks for ratio of $\frac{d'}{d} = 0.1$; but for thin slabs, such as are used for floors where the ratio of $\frac{d'}{d}$ considerably exceeds this value, the error entailed by the use of these curves is considerable. The approximate formula given above may then be used to advantage.

The derivation of the approximate formula is as follows:

Fig. 2 shows in dotted lines the curves for the arm of the resisting couple, as derived by the exact formulas when the ratio of $\frac{d'}{d} = 0.1$, and for values of p and p' from ½% to 2%. Full straight lines closely approximating these curves are drawn radiating from a single point, the coördinates of which are at $p' = 4\%$ and $j = 0.92$. These lines intersect equal intervals on the ordinate j, and if they are assumed to be the correct curves for the percentages shown, the equation of any such line having the same origin is seen by inspection to be

$$0.92 + 100\,pp' - 4\,p \qquad (2)$$

Curves for other values of $\frac{d'}{d}$ are not shown on the figure, to avoid complication, but the following relations are found:

For all values of p, from ½% to 2% at least, the lever arm decreases very nearly 0.02 for each 0.1 increase in $\frac{d'}{d}$ when the compressive reinforcement = ½%, and 0.05 for each 0.1 increase in $\frac{d'}{d}$, when the compressive reinforcement = 2%, and proportionately for intermediate values of the compressive reinforcement. This may be expressed as follows:

$$\textit{Decrease in value of lever arm} = 0.1d + 20\,p'd$$

Formula (2) may then be modified to express this variation, and we have

$$j = 0.93 + 100\,pp' - 4\,p - 0.1\frac{d'}{d} - 20\,p'\frac{d'}{d} + 2\,p'$$

which is formula (1).

The tensile reinforcement will limit the moment of resistance of the beam unless the percentage of tensile reinforcement is high and the percentage of compressive reinforcement low; hence the position of the neutral axis for determining the stress in the concrete need not be found for ordinary cases.

The above formula assumes the ratio of the moduli of elasticity for steel and concrete (= n in exact formula) to be 15.

A New Moist Closet for Cement Test Pieces

By Clarence N. Wiley*

When the proper percentage of water is added to a cement and the mixture worked into a paste, the paste is said to be of normal consistency. In order to secure uniform results, it is necessary that this percentage of water remains in contact with the cement particles until they have absorbed all they require for the chemical reaction. This reaction is not completed until some hours after the gaging. If these test pieces were allowed to remain in the air of the testing room, some of the water would be absorbed by the surrounding atmosphere and this absorption or evaporation might extend to such a degree that there would remain insufficient water for the proper hardening of the cement.

To guard against this, it is customary to store these test pieces, for a period of from 20 to 24 hours after mixing and molding, in a "moist closet." This receptacle may be constructed in a number of different ways, depending on the magnitude or importance of the work. If only a few small test pieces are made, these may be set in a shallow pan which is then covered with a wet towel or cloth. If a large number of test pieces are made at regular intervals a more elaborate receptacle is required and nearly every testing laboratory has a type evolved through experience or circumstance. These moist closets are made of some nonabsorptive material, such as soapstone, slate or concrete and are provided with shelves of glass or metal. The moisture is supplied usually from a pan of water resting on the floor of the closet and in this may be a large sponge for increasing the rate of evaporation or strips of felt or other cloth of good capillarity may extend from the water up the sides and across the top of the interior.

The author has used and constructed a number of different forms, but in all of them it was found difficult to maintain a uniform degree of humidity throughout the entire closet. Last year while examining a section of plaster tile through which were a series of longitudinal holes about 1 in. in diameter, an idea presented itself which was worked out as shown in the accompanying sketch. The basic idea in this design is the use of a porous concrete for the interior walls of the closet with openings in the walls which can be filled with water, thus allowing the humidity to pass through the walls and permeate the entire closet. The outside walls are of waterproofed concrete and therefore dry.

The legs and base of the closet were first cast of 1 part cement, 2 parts sand and 4 parts gravel to a point 2 ft. 6 in. above the floor. The top surface of this concrete was roughened before final setting so that a good bond would be made with the upper section. The forms of this top section were then built and 17 wooden rollers were turned to a little over 1 in. in diameter and cut into lengths of a little over 2 ft. These rollers were then set in the forms in a vertical position around the walls of the closet and securely fastened by nailing a light strip to each one and then to the forms so that the rollers would remain in position. The surface of the rollers was thoroughly soaped. A light partition was then placed ½ in. back of the rollers and fastened to the forms.

A mixture of cement and very fine sand in the proportion of 1:4½ was then made with water only sufficient to make the consistency of the mortar like that of moist earth. This mortar was then carefully tamped into the form and around the rollers. Small portions were introduced at a time and thoroughly tamped so that the mixture was made as dense as possible. When the mortar had reached the top of the rollers, it was covered with a damp cloth and work was discontinued for two days. At intervals the rollers were turned so that the moderately dry and weak concrete would not be cracked when removing them, thus enlarging the openings in the concrete to nearly 1½ in. in diameter.

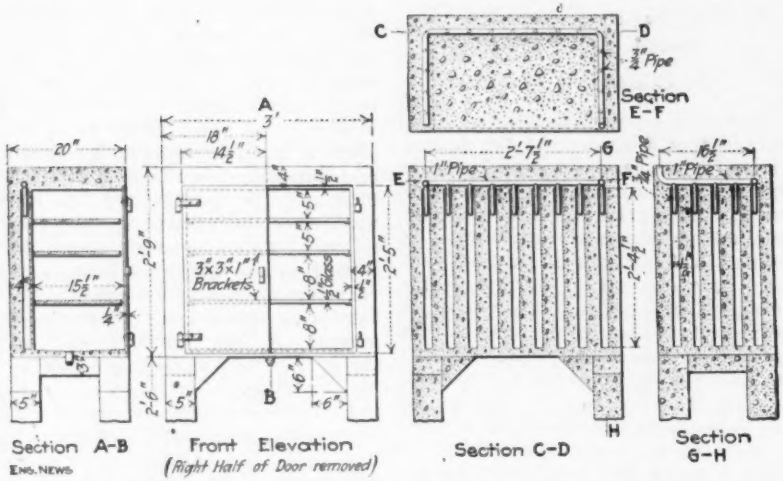
At the end of the second day the concrete was hard and the rollers were removed. There was then set in place horizontally along the top of the closet a section of 1-in. galvanized pipe with seventeen vertical ¾-in. branches, one of which projected some 5 in. into each of the cavities left by the rollers. The temporary partition was removed and a fairly wet cement paste was carefully worked around the top of each cavity, so that the cavities should be entirely closed at the point where the ¾-in. pipe entered.

A rich mortar was then made of cement and sand and 3% of waterproofing compound. The forms were entirely filled with this and the top of the work smoothly trowelled. At the end of a week the forms were removed and the concrete was found to be perfectly smooth and hard. The inside of the closet had the appearance of a poorly seasoned concrete building block and the surface was dull and dry in appearance.

Small pieces of lead had been fastened to the inside form at the proper levels for shelves and to these were screwed galvanized-iron brackets. Pieces of lead had also been incorporated for fastening the door hinges. Glass shelves were then placed on the brackets.

It was the intention to make the doors of concrete. This was done by cutting pieces of expanded metal lathing to the proper size and plastering on both sides. After these were hung, they were adjudged too unwieldly and heavy and

*General Manager, Atlantic & Gulf Portland Cement Co., Ragland, Ala.



A MOIST CLOSET WITH PIPES IN POROUS WALLS FOR CARRYING MOISTURE TO THE INTERIOR

sheet-iron doors, coated with an asphaltum paint were substituted. The bottom of the interior was sloped toward a central outlet for drainage.

The water was then gradually turned into the pipe line and in a short time the walls became damp and small drops of moisture appeared on the surface. The cavities were filled up and the water turned off. In a few hours the walls and ceiling were saturated with moisture and there was a slight trickling down the walls which kept the floor moist. After the closet had been in operation for a few days, experiment showed that the humidity was constant throughout.

This closet has been in daily use for over a year and its success warrants its invention.

Maximum Moments at 2-ft. Intervals Under Class E-50 Loading

BY GEORGE L. JENSEN*

In reference books on railway-bridge design are to be found various tables and diagrams for moments due to engine loadings, involving various lengths of spans and different conditions of loading. In most of these tables and diagrams the maximum moments, the position of the wheel producing the maximum moments and the class of loading only are given. In some few cases the moments for the quarter points are also given, but in no case, so far as the writer has been able to find, have tables or diagrams embracing conditions at points other than these points of maximum moments and quarter points been published. So far as steel-bridge design is concerned, it is not particularly necessary that moments at points other than these be known. With reinforced-concrete design, however, it is advantageous, in fact it is economically necessary, that moments at many points be known. Such moments as are needed and as many of them as are needed may be computed either by straight computations or with the assistance of Gibson's tables† or other similar tables, but making such computations when needed is a laborious process and is a process that will be repeated time and time again if no record, in the form of tables, is kept. The accompanying table is intended to supply this need.

The notes to the table are self-explanatory. The table has been carried only as far as spans of 40 ft., for it is seldom that concrete railway spans of lengths exceeding this are used.

In making the computations, the following fundamental rules of mechanics were carried in mind:

For the two concentrated loads:

When the length is less than 1.71 times the distance between loads, then place one load at the point under consideration and the other load off the bridge for maximum moment.

For the engine loading:

The distance between the point of maximum moment and the center of gravity of the loads must be bisected by the middle of the span.

If L/L' times the loads ahead of the point, not including the load at the point, is less than the total load on the bridge, and L/L' times the loads ahead of the point, including the load at the point, is greater than the total load on the bridge, the point is loaded for maximum moment. Here L is the length of the span and L' is the distance from the point of support to the point of loading.

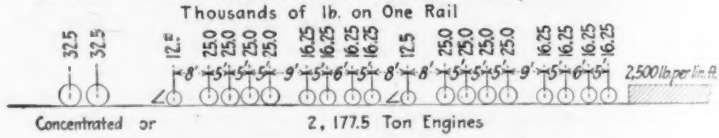
*Architectural Engineer, Board of Education, Chicago, Ill.

†Engineering News, June 25, 1906, p. 695.

A Railway Spike with a special holding device has been patented by Thomas C. Hanson, of 1729 North Kedzie Ave., Chicago, Ill. The device consists of an ordinary spike with a groove about four-fifths of its length on one side. Into this groove is driven a round iron bolt or nail, so notched as to be bent into a V when the end is driven against the bottom of the groove. Tests made at the University of Wisconsin show a holding power of 3500 lb. against 2850 lb. for an ordinary spike.

BENDING MOMENTS IN THOUSANDS OF FOOT-POUNDS FOR CLASS E 50 LOADING

Thousands of lb. on One Rail



POSITION OF WHEELS FOR LARGEST MOMENTS

To right and above upper dash line concentrated load is at point.
To right and above heavy full line wheel 2 is at point.
To right and above lower dash line wheel 3 is at point
To left and below lower dash line wheel 4 is at point.

Span in feet	Max. Moments: Distance from ctr.	Max. Moments: Moment	Distance from Center in Feet: 0	2	4	6	8	10	12	14	16	18
10	0.0	81.3	81.3	68.3	29.3							
11	0.0	89.4	89.4	82.7	53.0							
12	0.0	100.0	100.0	97.5	70 4							
13	0.0	118.8	118.8	112.5	87.5	22.5						
14	0.0	137.5	137.5	127.7	104.5	44.1						
15	0.0	156.3	156.3	143.0	121.3	65.0						
16	0.0	175.0	175.0	158.4	138.1	85.3						
17	0.0	193.8	193.8	180.9	155.0	105.1	26.5					
18	0.0	212.5	212.5	205.6	171.5	125.0	52.8					
19	1.25	233.2	231.3	230.3	193.4	147.4	78.9					
20	1.25	257.8	250.0	255.0	220.0	170.0	105.0					
21	1.25	282.4	275.0	279.8	246.4	192.9	131.0	31.0				
22	1.25	307.1	300.0	304.5	272.7	215.9	156.8	61.4				
23	1.25	331.8	325.0	329.3	298.9	233.7	182.6	91.3				
24	1.25	356.5	350.0	354.2	325.0	262.5	208.3	120.8				
25	1.25	381.3	375.0	379.0	351.0	291.0	234.0	150.0	34.2			
26	1.25	406.0	400.0	403.8	377.0	319.2	259.6	178.9	67.9			
27	1.25	430.8	428.1	428.7	402.8	349.5	285.2	207.4	101.4			
28	0.39	456.9	456.3	453.6	428.6	379.7	303.3	235.7	134.5			
29	0.39	484.9	484.4	478.4	454.3	409.7	336.0	264.7	167.3	37.5		
30	0.39	513.1	512.5	503.3	480.0	439.8	368.5	294.4	199.9	74.4		
31	0.39	541.2	540.5	531.8	508.7	469.7	400.8	323.6	232.2	111.2		
32	0.39	569.3	568.8	560.2	537.4	499.6	432.8	353.0	264.4	147.7		
33	0.39	597.3	596.9	588.5	566.0	529.5	466.8	382.2	296.3	184.1	40.9	
34	0.39	625.5	625.0	616.9	594.8	559.3	500.7	416.2	328.1	220.3	81.7	
35	0.96	653.7	653.1	648.9	627.4	589.0	534.6	452.5	359.8	256.3	121.2	
36	0.96	685.8	681.3	680.8	659.9	618.8	568.4	488.6	394.0	292.1	160.8	
37	0.96	718.0	714.7	712.8	692.5	651.2	602.2	524.6	426.9	327.8	200.0	44.1
38	0.96	750.0	746.9	744.8	725.0	683.7	636.0	560.4	459.9	363.3	238.9	87.5
39	0.40	783.3	783.1	776.8	757.5	720.2	669.7	596.0	499.9	398.7	278.3	130.7
40	0.40	819.4	819.4	807.9	790.0	756.8	703.4	633.6	539.8	434.1	317.5	173.6

Letters to the Editor

Pre-College and Vacation Training for Engineering Students

Sir—I have read with great interest the excellent paper by Prof. Herschel and the comment thereon by Prof. Rogers, in your issues of July 18 and Aug. 1. I agree with them both on the value of preliminary training in actual engineering. It arouses the student's interest, teaches him the value of technical education, gives him practical ideas, trains him to work and especially to "rush" a job through. All this may be accomplished by vacation work, although some experience before entering is desirable.

I do disagree, however, on the value of practice as a means of *instruction*. The idea in actual work is to teach a man one thing and keep him at it. Even where it is attempted to give the beginner a varied experience, it can seldom be done logically. In contrast, in college, his schedule is arranged in the proper order and he is allowed just enough time to master one subject and he is then passed on to the next. Suppose a civil engineering student at the end of his junior year secures employment with a topographic corps to run the level under chief of party. He will learn how to run the level and a little about topography and that is about all. Outside of the manual dexterity, this might all be acquired in six properly conducted exercises of three hours each. The efficiency of practical work as a method of acquiring technical information as compared to schools certainly does not exceed 20%.

On this account, I believe that instruction, both theoretical and practical, should be given in our technical institutions. I hear it said that certain practical features may be learned after graduation. Let me say that information acquired in this way comes slowly and often as a result of bitter experiences. A man's capacity for supervision is then limited by his actual work.

We hear a great deal about "theory"—questions of strength, deflection, and economy of material—as opposed to "practice"—economy of fabrication, erection, operation, and so forth. Why are not the principles of one as important as the other? And are not both capable of careful and painstaking analysis? It is said that practice does not have the same value in mental training. With this I cannot entirely agree. For example, is it not good discipline to evolve mentally the processes by which a bridge must be erected and the various pieces connected? Even the common "right" and "left" of the mechanic involve thought; I cannot see why it is not utilized to give Descriptive Geometry a more practical development.

In conclusion, while I believe fully in the value of preliminary and vacation experience along professional lines, instruction should cover theory and practice together as thoroughly as time will permit. The best engineer is a broad man; not one trained to a single side of the subject.

HORACE R. THAYER,
Asst. Prof. Structural Design,
Carnegie Technical Schools.
Pittsburgh, Penn., Aug. 12, 1912.

Natural Mixtures of Sand and Gravel

Sir—Referring to the letter from Emile Low, in your issue of Aug. 8, 1912, p. 262:

A natural gravel is extensively used in structures of the Barge Canal. At this end of the state that coming from the Niagara River is in favor. As a control over the mixture, frequent field tests of the proportions of sand and stone in the natural mixture are made. The principal stress is laid on having the mortar of the proper proportions, that is, on the proportion of cement to sand, for this is the vital part of concrete. So, if the tests for voids in the sand of a certain natural gravel show that a mixture of 1 cement to 2.5 sand is necessary in order to fill these voids by at least a 20% margin and therefore a 1:2.5:5 concrete has been decided upon, the main object is to get a concrete that will contain a mortar of 1:2.5 and not leaner. A mortar much richer than this might also be detrimental. Less importance is attached to the proportion of stone to cement, as long as this does not overrun or greatly fall short of that required. Below are two examples of field tests, picked at random from a great many. In each case a 1:2.5:5 concrete was wanted. Everything over ⅛ in. in size is classified as stone:

Case 1.—5 cu.ft. natural mixture screened gave 1.75 cu.ft. sand and 4 cu.ft. stone. Here there was a deficiency of sand (less than half as much sand as gravel) and therefore the amount of stone in the natural mixture became the controlling factor in our calculations, which were as follows:

5 cu.ft. natural mixture contain 4 cu.ft. stone. Therefore, to get 5 cu.ft. stone, 6.25 cu.ft. of the mixture had to be used. When so mixing we obtained an amount of sand as follows:

5 cu.ft. natural mixture contain 1.75 cu.ft. sand. Therefore 6.25 cu.ft. of the mixture contained 2.2 cu.ft. sand. In this case, then, we get a 1:2.2:5 concrete by mixing in proportions of 1 cement to 6.25 natural mixture and 0.3 cu.ft. sand from a local pit was added, resulting in a 1:2.5:5 concrete.

Case 2.—Another shipment of gravel gave the following result:

10 cu.ft. natural gravel gave 4.75 cu.ft. sand and 7 cu.ft. stone. It is seen at a glance that there is more than half as much sand as stone and consequently we first investigate how much of the natural gravel to use in order to give a 1:2.5 mortar, while in the first test we first found how much natural gravel to use in order to give proportions of 1 cement to 5 stone.

10 cu.ft. natural mixture gave 4.75 sand. Therefore to get 2.5 cu.ft. sand we have to use 5.25 cu.ft. natural mixture. In this 5.25 cu.ft. will be how much stone?

10 cu.ft. natural mixture gave 7 cu.ft. stone, so that in 5.25 cu.ft. we will have 3.7 cu.ft. stone.

A mixture, then, of 1 cement to 5.25 natural gravel will give a 1:2.5:3.7 concrete. We therefore add 1.3 cu.ft. stone, in this case obtained by screening some of the natural gravel. For certain work, however, the shortage in stone would not be considered detrimental.

I would emphasize the necessity for making such tests in large quantities. It has been our experience that the test of a small quantity, say 1 cu.ft. only, showed too low an amount of stone, due to the fact that in taking the sample from the pile, some of the larger stone are left out (1½ in. size) and this, in a small sample, introduces a considerable percentage of error. For the same reason the amount used for the test should be taken in as large batches as possible from the pile before being measured out in such small measures as a water pail or box.

Since too rich a mortar is preferable to one too lean and the contractors generally prefer to measure the gravel directly in the wheelbarrows in which it is transported to the mixer, they are held

down to a lower amount of gravel per cubic foot of cement than theoretically called for by the tests I have described, to allow for irregularity in the heaping of barrows. For this reason, and since often the amount of stone used is below the full amount allowed in the mixture specified (for instance, in the second test, if this mixture were used without addition of stone there would be only 3.7 parts stone instead of an allowable 5), it is evident that cement would be saved by mixing all the ingredients separately by actual measurement. The contractors have usually preferred, however, to stand this loss than to screen and remix the natural gravel or to furnish sand and crushed stone in this part of the state.

In the instance cited on p. 257 of ENGINEERING NEWS, Feb. 8, 1912, the contractor by mixing 1 cement to 5 natural gravel (if this was actually used and there was no heaping of the measure) was getting a good deal the worst of the bargain, as he was giving a 1:2.25:3.75 concrete instead of a 1:3:5. This certainly can not have been a bad concrete for a place where 1:3:5 was considered rich enough.

ARTHUR S. MILINOWSKI,
Assistant Engineer,
N. Y. State Barge Canal.

Albion, N. Y., Aug. 12, 1912.

Shall the Designation "Engineer" Be Changed?

Sir—In your last issue, a correspondent who speaks of the disputed title of engineer, cites the word *"engine* as the basis of our appellation," and suggests that we might relinquish this name to our more deserving competitors, the locomotive drivers, and term ourselves "energiers." While Mr. Keyser is probably more of a humorist than otherwise, yet his interpretation of the meaning of engineer is so generally and wrongly believed, that it is not amiss to show its etymology. Engineer is not a derivative of engine, but the two are both derived from the Latin "ingenium" (innate ability). An engine is an invention; an engineer is the inventor, not the operator. The verb engineer is used in its original sense when one says "a political movement is engineered." Engineer is not formed by adding a suffix to engine. Engineers existed before there were any engines (i.e., steam and heat engines). Note the lines from Hamlet:

> For 'tis the sport to have the enginer
> Hoist with his own petar.

This older form, and also the modern one, are simply taken bodily from the old French. The origin is ancient and reputable; it dates further back than the federations of engine runners.

It would, indeed, be an ill-planned movement to give up a name to which we are rightly entitled because it is unjustly used by those who have no right to it. Railroads generally call their employees "engine runners," "engine drivers," and "enginemen." To call these knights of the monkey wrench "engineers" is simply an exaggeration (probably of their own), and it is entirely an Americanism.

When any attempt is made to call a thing by a name better than it deserves, that word is apt to be degraded. In order that a bar might seem not to be a bar, it has been successively called a saloon and a café (to the disrepute of these other places), and yet it fools nobody. Enginemen like to be called engineers; it does not alter their occupation, but it makes people doubt ours. For us it is like giving a dog a bad name and hanging him. Not that I look down upon locomotive drivers—since the disclosures of their wages at the strike hearings, I have been inclined to look up to them. I admire them as mechanics, and hope that I may use the monkey wrench only as well; but we of the slide rule do not respect the men of any occupation who misappropriate our credentials. Let us at least keep our time-honored name, if not our salaries!

A. W. BEDELL.

Chappaqua, N. Y., Aug. 7, 1912.

Sir—Mr. Keyser's letter in your issue of Aug. 1 brings to mind the derivation of the word designating the engineering profession in foreign countries.

In France, Germany and Southern Europe the man who "adapts the forces of nature" is called "Ingéneur," "Ingenieur," "Ingenario," etc., all from the Latin "ingenium" which means capacity or invention, and from which same root the French and old English word "engin" and later the modern word "engine" were derived. Would not the spelling of the word in accordance with its ultimate derivation be better than the present usage? Why not spell the word as many cultivated English engineers pronounce it, "ingeneer"? The derivation would be apparent and it would mean one who "ingenes," not one who uses or commands what the "ingeneer" has designed or constructed. Our foreign friends would translate one meaning of "engineer" by "mécanicien" or "machinist," but they would always translate another meaning of the same word by one derived directly from the Latin "ingenium." Why should not we make the same distinction?

In the writer's opinion, the least important reason for the use of the word "ingeneer" would be to distinguish professional engineers from those who hoist coal, make ice, etc., for the character of the engineering profession, no matter what word be used to designate it, is dependent entirely upon the personalities of its units. The use of the word "engineer," however, would be a gain in accuracy, for which engineers are supposed to strive.

ROBERT SPURR WESTON.

Boston, Mass., Aug. 3, 1912.

[Changing the name of a profession, like spelling reform, is easier said than done. Certainly there is little reason for abandoning a name long well established in the English language, dignified in character, convenient in use, and no farther astray etymologically than a host of other words in the English language, just because the name has been appropriated by the men who build engines and all sorts of other machines, as in England, and by those who run engines after they are built, or who install plumbing and heating apparatus, as in the United States.

As showing the futility of attempting to hold any name, old or new, for the exclusive use of any profession or trade, short of those which can be covered by copyright or trade mark, we insert a letter which has been received since the preparation of this tail note was begun. The letter is from W. H. Woodcock, Lewis Block, Buffalo, N. Y., and is as follows:

> Sir: Mr. Keyser is somewhat late with his suggested rename for "Engineers," as that very name has already been appropriated by an establishment in this city, as follows:
>
> ENERGIER
> Dry Cleaning
> Brace & McGuire Co.

This seems to settle the case for "energier," at least, and should discourage others from attempting to rename the engineer and engineering.—ED.]

Notes and Queries

Errata—In the article on p. 228, of our issue of Aug. 1, 1912, entitled "Pumping Engine Tests: New Orleans Filtration Pumping Station," there are two errors: Table I, third column heading reads, "normal capacity 5% increased head," should read, "normal capacity 50% increased head"; and in the next to the last paragraph of the article the second sentence should read, "The steam consumption of the . . . engines . . . was 13.011 and 13.5 lb. per hp.-hr., respectively.

A Turbidometer for measuring the amount of emulsified oil in condensate or boiler feed water has been put out by the Harrison Safety Boiler Works of Philadelphia. This instrument is a long graduated test tube made of clear glass, except at the bottom, which is opalescent, with a small black spot in the center. To use the instrument, the sample of condensate is poured into the tube slowly until the spot disappears, while the observer looks straight down to the bottom. With water that is at all turbid the black spot will gradually disappear owing to the diffusion of light by the suspended particles. The graduation on the tube is made by calibration to show the amount of oil in emulsion in grains per U. S. gallon.

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*Illustrated.

Engineering News

A number of questions relating to foundations on low-grade rock are brought to the open anew by the failure of the Ohio River movable dam near Gallipolis, Ohio. The conditions surrounding the design and construction of this dam were in every respect such as to produce ample rather than scanty margins of safety. No great difficulties or points of uncertain knowledge are involved in building a dam to resist a head of 10 to 15 ft., which means a maximum downstream pressure of only about three tons per running foot. Regarding the downstream pressure as concentrated entirely on the vertical face of rock at the lower edge of the foundation concrete, and taking this as 2 ft. thick, the bearing pressure under the head which prevailed at the time of failure was something less than 1 ton per sq.ft.; or, regarding it as distributed over the foundation area, there was a sliding pressure of perhaps 150 lb. per sq.ft. of base. Yet under these remarkably moderate conditions an accident occurred which in all appearance is the utter failure of the rock to resist the horizontal pressure.

There is small reassurance against this conclusion in the fact (stated in our report on another page of this issue) that the foundation trench was thoroughly cleaned out of all loose or easily loosened rock layers, so as to get down to a reasonably hard and coherent foundation rock. Beds of shale exhibit many variations of behavior, and not infrequently may disintegrate or show weakness or altered character after a time, though on first exposure they may appear sound.

The similarity of this accident to what occurred at Austin, Penn., a year ago need hardly be pointed out. Similar rock types, speaking generally, were involved in the two cases, and the same direct downstream sliding resulted. The similarity ceases, of course, in a comparison of the events prior to failure. Such a primary failure as occurred at Austin, giving plain warning (none the less plain because flatly disregarded), did not appear in the Gallipolis case.

Failures of this kind are likely to lead to the conclusion that in cases of foundation on shale it will be well to regard the subsoil as mere earth, at least in its relation to horizontal pressures. The vertical bearing capacity, doubtless, will usually be taken as far higher than all ordinary earth except the firmest hardpan, but for all other purposes the demand for depth of foundation excavation and full anchorage will be similar to those usual in the case of earth foundations.

It is fortunate that the Gallipolis accident occurred under a jurisdiction which will ensure a searching investigation of the conditions prevailing at the site. It is highly desirable that the subject be illuminated as much as possible by a study of all the facts bearing on the matter, since these failures are, in effect, full-size tests of a material often met with and often required to be utilized. The necessities of the case may call for the speediest possible beginning of reconstruction of the wrecked dam, but we still would urge upon the authorities that it is important to make a complete study of the failure and the physical facts connected with it, even at the risk of delaying the rebuilding a considerable time.

A hard campaign for a safe milk supply for Chicago ended in a notable victory on Aug. 14. Several years ago the city council passed an ordinance requiring that all milk offered for sale in Chicago which was not from cows proven by the tuberculin test to be free from tuberculosis must be pasteurized. As a result about 70 per cent. of the supply was being pasteurized when the Illinois legislature, placing the alleged interests of the dairymen above the public health, passed an act making it unlawful for any city to demand the tuberculin test. The city attorney of Chicago, for reasons which we do not understand, declared that the statute just named invalidated the whole of the Chicago milk ordinance. A new ordinance, containing adequate provisions governing the public milk supply, was defeated in the council on July 22 by a vote of 37 to 26. Since then the health department has done the best it could under limited authority and with an utterly inadequate force of inspectors. The magnitude of the work of inspection may be partly appreciated when it is known that the milk supply of Chicago comes from some 12,000 farms in four different states, distributed over 11,000 sq. miles of area. The defeat of July 22 stimulated the friends of safe milk to such vigorous action that on Aug. 14, at a special meeting of the city council which broke into many vacations, the desired milk ordinance was passed by a vote of 49 to 9—three more than the necessary two-thirds vote of the 69 members now constituting the council. Under the new ordinance, any milk which does not comply with a described standard

must be pasteurized. This milk campaign was led to victory by Dr. George B. Young, health commissioner of Chicago; Dr. Willis O. Hance, chairman of the City council committee on health, and Mayor Harrison, among city officials, backed by various civic organizations, and by individuals within and outside the city government. The next move will be to induce the legislature to repeal the anti-tuberculin test statute.

The British Government proposes to establish, practically throughout the length and breadth of its dominions, wireless-telegraph service eventually more complete and extensive than the submarine cables systems in existence. The general features of the scheme are noted elsewhere in this issue. Judging from the price to be paid to the Marconi company, $300,000 per station, all of these installations are to be of the highest class, irrespective of some being placed on the outposts of civilization. The government proposes to handle all messages submitted for transmission, official communications of the government, of course, being given priority. This seems like a world-wide extension of the Post Office telegraph system in competition with the private cable companies. The rates are to be fixed, of course, by the Postmaster General, but it is reported that the system is intended to be self-supporting. Each station is to be charged with its own expenses, and credited with its own revenues. The rates, we understand, are to be adjusted, so that the revenues from a given station will cover its expenses. This means, perhaps, that private users must pay for the unrestricted official use by government agents, which may monopolize the service most of the time. There is a possibility that under such conditions the rate necessarily imposed to support a station will be too high to win traffic from the cable companies. Then the only plan which will attract traffic will be to charge the government for its messages and to arrange the rates from a station so that the expense is distributed over the entire service, official and public.

Hardships of Public Service Officials in Relation to Dividends

In the first issue of the official publication of the American Electric Railway Association (August, 1912), ten pages are devoted to a speech by T. N. McCarter, president of the Association, and president of the Public Service Corporation of New Jersey, a company which is the owner of gas, electric and street-railway utilities for practically all northern New Jersey. This speech is described in the magazine as typical of those delivered in 28 leading cities during a recent trip of the executive officers of the Association, undertaken to create better relations between the street-railway industry and the public.

In this speech Mr. McCarter frankly admitted that abuses had been practiced by the early promoters and beneficiaries of public-utility companies, but he urged his hearers to believe that this nefarious exploitation had ceased.

To these early mistakes he attributed the antagonism of the public toward the public-utility companies. He spoke appreciatively of the benefit of wise and honest public regulation of the utilities and asked that everywhere the short-term franchise be eliminated for the good of the industry and the public. In regard to the watering of stocks, which he admitted might have taken place in the past, he asked the public to accept present conditions as they are found, since the old disseminated securities are protected, being senior securities, so that any repudiation of obligations would fall hardest on the men who had recently put in honest money.

One of the points upon which he dwelt most was the evident desire in many districts to restrict the earnings of public utility concerns to 6 or 7 per cent. He spoke in this fashion:

> If that doctrine is to successfully take hold of this country and become the law of the land then the electric-railway industry is dead. This industry is by no means a pleasant one for those who are engaged in it. It is fraught with many annoyances, many things that are unpleasant and hazards that are extraordinary. If we are to be limited to 6 or 7 per cent. as a maximum earning after bearing all these annoyances and hazards, after going through the lean years through which all new enterprises of this character must necessarily be subject, then I for one would rather go into some other kind of business.

With every well considered effort to promote better relations betwen franchise companies and the public we are heartily in sympathy. We feel, however, that in many cases, as in the one cited, the officials are seeking in a subtle way unduly to increase the burden on the customers for the sake of the stockholders.

Doubtless this is unconscious and well intended. It probably arises from the fact that the officers of these companies have not completely separated their relations as officials and as stockholders.

A question which may properly be raised is how far the inherent unpleasantness of the business felt by salaried managers is also felt by the stockholders as such and should be a factor in fixing what is a legitimate return on the investment in municipal franchise companies. We think everyone will admit that the stockholders should be reimbursed for the use of their money, including any attendant risks. As for unpleasant experiences, it is a part of the duty of officials like Mr. McCarter to bear these. Salaries probably are, and of course should be, adjusted accordingly, but these burdens on the officers are no reason for increasing the return to the stockholder.

The Arbitration of Locomotive Engineers' Wages

There is no question before the Supreme Court of the United States, and no bill pending in Congress, which is fraught with greater importance to the public than the question which is before the Arbitration Commission now investigating the demands for higher wages by the locomotive engineers on the railways east of Chicago.

We do not mean that this question by itself is of such surpassing importance. Whether these railways do or do not increase the wages of enginemen by a total of between seven and eight million dollars per annum is a matter in which the railway companies and the enginemen are chiefly interested. But on the settlement of this question hinges the question whether a similar or greater percentage of wage increase shall be made to all classes of railway employees; and if they may get such an increase this year, why may they not get a like increase next year, and another the year after? Where is the limit to be set to the increase in railway wages?

And this question is not merely a question between the railway companies and their great army of employees. It is not a matter of the companies merely reducing the dividends to their stockholders, and paying the money to employees instead, for the unfortunate fact is that, taking the railways as a whole, there is no great fund of surplus earnings which can be drawn upon to pay any such large increases of wages.

The railway officers who have appeared before the Commission have argued for the solvency of their companies, but they have really been representing the great general public which their railways serve: the farmer, and the laborer, the miner and the carpenter, the millions of men and women who work for wages or salaries. It is the question whether all these people, on whom the increased cost of living now bears hardly, shall be compelled to pay higher fares for passenger travel and to pay higher freight rates on what they eat and wear, on coal for their stoves, and lumber and bricks for their houses, in order that the men who work for the railways shall have higher wages.

It is time that the public realized that every compulsory expenditure which is forced upon the railway companies must be paid for by the public itself. The railway has become a public institution, all its business is open to the public, and is under government inspection and control. It must maintain a certain stand-

ard of service. State Commissions prevent reduction in the number of trains, and require track and bridges to be kept in safe condition, grade crossings to be removed and old stations to be replaced by new. Its rolling stock must have safety appliances required by state and national legislation. It must compensate its employees injured in accidents on a scale fixed by a Federal law. It must charge the same rates to all; and increases in rates are possible only by permission of state and interstate commissions.

Under these conditions, where is the railway to find the money to pay increased wages to employees? The popular idea, of course, is that the railway is a rich corporation, and that there is an unlimited fund growing into the pockets of railway bondholders and stockholders, which can be drawn upon to pay higher wages to enginemen and brakemen and trackmen.

But the official statistics of railway earnings and expenses prove conclusively that returns on railway capital cannot be materially reduced without widespread railway bankruptcy; and the public will not stand for bankrupt railways or bankrupt railway service. Further, there is a very potent reason why the capitalist may not be robbed in order to pay more money to the wage earner. The railway system of the United States requires the investment of hundreds of millions of additional capital to enable it to keep pace with the requirements of increasing traffic and with the public demands for safety and comfort. This money can only be obtained by the sale of stocks or bonds, and the better the returns on present railway capital the more favorable will be the terms on which the necessary additional capital can be obtained.

To put the same thing in other terms, if exorbitant demands of labor unions or heavy taxation or forced expenditure for safety appliances and passenger stations or other unproductive investments, materially reduce the returns on railway capital, then railways will be unable to sell bonds and work on improvements and extensions must stop. Not even by this means, however, can the railways evade the necessity of obtaining additional capital. Railway bonds which mature will have to be paid by issuing new bonds bearing a higher rate of interest. Thus the very attempt to take away part of the capitalists' profits and give it to the wage earner will have the ultimate result of increasing the percentage of earnings which will have to be paid to capital.

This is even now coming to be a condition and not a theory. No railway corporation in the world has higher credit rating than the Pennsylvania R.R., yet it has to renew its bonds falling due this year at an increased interest rate of about 1% over that of the bonds retired. While this is largely due to the general increase in the interest rate on capital, it also reflects the distrust felt by investors of the future of railway securities.

The real question to be settled by this Arbitration Commission, then, assuming that it goes to the bottom of the matter, as it should, is whether the service which the locomotive engineer renders to the public is worth the price which is asked; is worth it, that is, in comparison with the earnings of workmen in other occupations involving skill and fidelity. The man with his hand on the locomotive throttle carries a heavy responsibility, but so do many other men. In the railway service itself, the safety of a train load of passengers depends on the skill and faithfulness of section foremen, roadmasters, bridge inspectors, trackwalkers, signalmen, conductors, dispatchers, trainmasters, brakemen, telegraph operators, and many other employees and officers as well as on the engine runner.

It may be claimed that the engine runner's responsibility is greater than that of other classes of employees; but even if this be so, he is already paid a higher rate than any other employee, and his monthly earnings are even larger than those of some of the officers to whom he reports.

The statistics presented in the arbitration proceedings show that on all the lines of the Pennsylvania R.R.'s system east of Pittsburgh and Erie, the average time on duty and the average hourly earnings of the locomotive engineers for the month of October, 1911, were as follows:

	Passenger Trains		Freight Trains	
	Through	Local	Fast	Slow
Ave. length of run, miles	118.4	84.9	108.6	79.2
Ave. hours on rail	4.18	4.46	8.03	9.11
Ave. hours on duty	4.68	4.96	8.53	9.66
Ave. earnings, per hour on rail	$1.23	$0.94	0.73	0.59
Ave. earnings hours on duty	1.10	0.84	0.69	0.56

In what other occupation employing large numbers of men can a man have, as do the passenger enginemen, a working day of only 4½ to 5 hours long with an average wage of $4 to $5 per day, the year round? It is an occupation requiring no preliminary education other than that of the elementary schools, no knowledge of a trade, no high degree of skill, intelligence or executive ability. The main requisites are good health, eyesight and hearing, good habits, strict obedience to orders. These qualifications are valuable and deserve adequate compensation; but they are qualifications which are possessed or can be acquired by very large numbers of men.

It is perfectly well understood that the present high wages of the locomotive engineers are the result, not of the free operation of the law of supply and demand, but of the power of the engineers' labor union. There are many thousands of men who would be very glad to exchange their present occupations for the short hours and high wages of the passenger engineman, and who would, with the necessary experience, be as competent and reliable as the men now in the service; but there is no open door to this occupation. The Brotherhood of Locomotive Engineers has a monopoly of the employment by contract with most of the railways of the country. It is because of the power and influence of this organization that locomotive runners enjoy their present rate of wages.

Nor is this the whole story. The railway companies have granted high wages to the engineers' brotherhood in the past, not alone because of the service rendered, but because the railway officers have realized their responsibilities to the public. They have realized that the interruption to railway service consequent upon a strike of locomotive engineers would mean losses to the public a hundred or a thousand times as great as the amount of wages at issue. The same thing is true of the demands of other railway labor unions. Peace has been purchased by one concession after another, not only in wages, but in conditions of service, until responsible railway officers declare that their roads are really run by the labor unions and the state and interstate commissions. The time of the railway officials is chiefly devoted to carrying out the regulations of the one or the other and making both ends meet if they can.

The present arbitration proceeding was brought about to avert a grave crisis. The locomotive enginers' brotherhood made demands for an increase of wages and was on the point of tying up all the railway lines of the east by calling a strike because the railway companies refused to grant these demands, declaring that the funds at their disposal would not permit such an increase.

Concerning this situation the remarks of J. C. Stuart, General Manager of the Erie R.R., before the Arbitration Commission, are worth giving. After presenting figures showing that if the increase of wages asked for by the engineers and other labor unions were granted, the Erie R.R., on the basis of earnings for the year ending June 30, 1912, would have a deficit of $842,000 Mr. Stuart said:

> During the past decade wages have increased and public requirements have increased so that the net revenue has been reduced until the railroads are unable to continue wage increases. Organized labor has been growing more powerful and is now controlled by able and aggressive leaders, who have organized so called "Legislative Boards," in Washington, and the majority of states.
>
> The power invested in these labor leaders, with their absence of responsibility, is alarming.
>
> In the past five years the company I

represent has received five strike votes. The leader in charge claimed he had the power to stop the highways of this country and expressed his intention to exercise it. To appreciate the gravity of this situation, imagine any other individual—a President of a railroad, or its directors—assuming to stop the public highways for any reason and deprive forty to fifty millions of citizens of the necessities of life.

If such an attempt were made, some drastic legislative action would immediately follow; and yet, at this period, there is no law to determine the responsibility of the leaders who possess this greater power and who have repeatedly stated their intention to exercise it.

The best test of their power is for the general public to attempt to pass a Federal Law to place responsibility upon organized labor engaged in interstate traffic. If the common carriers are responsible to the public, as operating agent, why should not employees, organized or otherwise, be held responsible to some extent to perform their duties to the public, as part of the complete transportation organization?

The engineers are engaged in a very natural attempt to secure an increase in their compensation; but when it was clearly explained to them that the railways were unable to pay the evidence was not effective.

A president of a strong labor organization, which within a year requested a substantial increase, was asked by the committee whether he had considered the ability of the railroads to pay, and where the money was to come from. He replied that he was not a financier and really did not know. Yet he had the power to stop the wheels on every railroad in the United States.

Other prominent railway officers have presented figures as convincing as these given by Mr. Stuart, showing conclusively that the increased wages demanded by railway employees, coincident with the decline in railway net revenues, make it certain that the money to pay these increased wages can only be obtained by increasing rates of fare and freight or, to put it in other words, raising the transportation tax to which all production and all business and the living expenses of every household contributes.

The large question before the Arbitration Commission, then, is whether engineers' wages are on a parity with wages in other occupations. For the settlement of this question, we know of no other final standard than the law of supply and demand. If the Brotherhood will consent to relinquish its monopoly, and allow other organizations to compete for the furnishing of this class of labor, it will then be determined whether the wages now paid are fair and just for the work done and the responsibilities carried.

The chief ground on which the enginemen have based their claim to higher wages is that the increased power of locomotives and length of trains meant an increase in responsibility deserving an increase in compensation. It has been shown, however, that the increases already made to enginemen during the past four years have been more than proportional to the increase in locomotive tractive power and train weights during the past decade. As for the theory that the wages of an engineer should be proportioned to the horsepower of the locomotive, it would be as reasonable to claim that the machine-shop operative running a 24-in. lathe should be paid a higher rate than the man on a 12-in. lathe. Under modern train-service conditions the responsibility of the enginemen is practically the same in handling a light train as a heavy one, and it is the measure of responsibility alone which can justify the present scale of wages to enginemen.

A World-Wide Wireless Telegraph Service for the British Government

Recently the British Government has issued the text of an agreement entered into between the Marconi Wireless Telegraph Co. and the Postmaster General regarding the eventual establishment of a chain of wireless telegraph stations throughout the extent of the British possessions. The agreement is dated July 19, 1912.

The agreement states that the company "shall provide, erect, construct and establish" a long-distance installation at stations which the Postmaster General shall specify, in England, Egypt, East Africa, South Africa, India and the Malay Peninsula, so as to provide efficient communication by wireless telegraphy between all or any of these stations. It is stipulated also that the company shall establish a long-distance installation at any such other station in the British Empire, or in any British protectorate, as may be hereafter specified by the Postmaster General, provided that during five years from the date of the agreement no long-distance installations shall be provided for the Postmaster General or for any government on whose behalf he has entered into the agreement, except by the Marconi Co. on the general terms of this agreement.

The long-distance installations to be provided are to be in accordance with specifications approved by the Postmaster General and any station is to be completed within 12 months from the date on which the company is notified that the site has been acquired and the foundation and buildings completed.

On the completion of any installation the company shall demonstrate that the plant is capable of continuous and efficient communication for commercial purposes both by day and by night with the next station or stations and with such other stations as shall be specified. The plant must send 20 words per minute with duplex ordinary working, and 50 words a minute with simplex automatic, after allowing for repetitions necessary to insure accuracy. The company is required to operate the stations for six months after completion, to make good any defects found during that period, and to receive and transmit wireless telegrams.

On giving the company a final completion certificate for any installation at any station, the plant becomes the absolute property of the government, and the Postmaster General or the governments are entitled at his or their absolute discretion to introduce into these stations "any patents or inventions or apparatus for wireless telegraphy in addition to and in connection with or in substitution for the Marconi patents", provided that before doing so the advice of the company shall be secured. The government is not obliged to act on this advice.

For each long-distance installation the company will receive the sum of $300,000. In case the company, at the request of the Postmaster General, erects and constructs any building or does any other work in connection with the station, the actual cost in labor and material is to be paid to the company, but no profit.

During a period of 28 years after the date upon which public wireless telegrams shall commence to be transmitted between the first three long-distance installations made under this agreement, the Postmaster General shall pay to the company as royalty for the use of the Marconi patents 10% of the gross receipts of the station at which long-distance installations shall have been provided.

During this royalty period the company and the inventor, Guglielmo Marconi, are required to give the Postmaster General and the government all information, assistance and advice respecting the patents and mode of working, and all processes necessary for the best advantage in successful and efficient working of the installation. The Postmaster General may terminate the agreement and the royalty period at the expiration of 18 years on giving the company six months' notice. Moreover, it is provided that during the continuance of the royalty period, if the Postmaster General decides to use another system of wireless telegraphy, not making use of any valid and unexpired patent of the Marconi company, then from the date of giving notice of such use the royalty period shall terminate.

The company has the right during the royalty period, or until the agreement or the royalty period shall be terminated, of inspecting the installation of any system other than the Marconi which the Postmaster General may install after the five-year restriction is ended. pro-

vided that the company has reason to believe their patents are being infringed. Such inspection is to be made in the presence of an officer of the Postmaster General and a representative of the proprietors of the system in question. The company is bound not to communicate or make use of any information obtained at any such inspection except for the purpose named.

The Postmaster General and the governments on whose behalf he has entered the agreement have the right to give any information concerning the Marconi patents or any knowledge obtained from the installations provided under agreement to any other department of the British government provided that such department shall have formally agreed not to make use of or divulge any information in order to enable them or others to manufacture or use without payment any of the apparatus in regard to which information is furnished.

In case the government of any of the British dominions or protectorates hereafter adopts the agreement, when the Postmaster General gives notice thereof to the company then this agreement is to be regarded as entered into by the Postmaster General on behalf of such governments.

The following specifications regarding the construction of the stations have been published. The wave lengths of all stations are to be as great as possible within the limits of 17,000 and 50,000 ft. to secure reliability of reception at all times of the day and night. However, the wave lengths from any one station are to be in all cases at least 25% different from those transmitted from other stations within its normal range and with which it has to communicate. In all cases throughout the imperial system there will be a difference of 5% between the wave lengths emitted from any one station in order that each corresponding receiving station with which this station has to communicate may be able to tune out the waves emitted by said station to receive from any other station or stations with which it is also communicating. The note of each station is to be different from those of any station within its range, but the notes of each transmitting circuit in any one station shall be identical, slight alterations being made possible, however, in case it is found desirable to provide for such change.

To standardize the apparatus so that the staff of one station shall be competent to look after the plant in another station, the height of the aërials, and the construction of apparatus, are to be alike, so far as practicable.

The transmitting aërials are to be of the multi-wire directional type, that is, with a center line through the horizontal portion of the transmitting aërial coinciding with the line of direction of the station, with which it is required to communicate, the free, or elevated end of the aërial, pointing directly away from the communicating stations. The masts for supporting the aërial are to be of 2 ft. 6 in. section steel tubes and are to be 300 ft. high. The earth system is to consist of a series of galvanized-iron plate buried and to be supplemented by a number of horizontal wires running to the boundaries of the site.

The power-plant apparatus is to be in duplicate and is to include two steam boilers. Where stations are to send in two directions, three boilers are to be provided and where transmission in three directions is required, as in East Africa, the station is to have four boilers. The prime mover is to be a steam turbine directly coupled to an alternating-current generator, in turn coupled direct to a Marconi revolving-disk discharger. Excitation for the alternators, lighting of buildings, fans, etc., is to be provided by two 110-volt turbo-generators. The total power at terminal stations is to be 1300 hp., but at the intermediate stations from 1900 to 2500 hp., according to the locality, range and number of directions in which transmission is required.

The receiving and operating station is to be not less than 10 miles from the sending aërial. The receiving aërials are to consist of one or more silicon-bronze stranded conductors supported by sectional steel masts 300 ft. high. The receiving aërial is to be erected parallel with the center line of the transmitting one. The receiving station is to be provided with a small out building containing a 5-hp. gasoline engine, coupled to a direct-current dynamo for supplying lighting to the operating building and current for the operating lines.

The high-tension signaling switches are to be electro-magnetically operated by relayed current, the relay being in the station at the transmitting aërial, but worked by a hand key in the operating station several miles away. Means will be provided, however, so that the signaling can be carried out from the transmitting station if it is necessary to do so at any time.

The agreement is not effective until approved by the House of Commons, the Governments of the Union and of Egypt, and the Secretary of State for India.

Report of Congressional Committee on the Florida Everglades Case

The Florida Everglades investigation, which has been under way for some months before a committee of the House of Representatives, was closed on Aug. 19 by the final report of the committee, after some forty days' hearings, which resulted in many hundreds of pages of testimony. The investigation arose principally from charges that certain government reports prejudicial to the Florida land-drainage schemes had been withheld by the head officials of the Department of Agriculture, but incidentally the dismissal of the engineers C. G. Elliott and A. D. Moorehouse, on charges of false certification of accounts, was an important factor in the inquiry.

The full report was not available in time for abstract in this issue, but the press accounts give the general tenor of the findings. There was a majority report, signed by three of the four democratic members of the committee, and a minority report, signed by a republican member who stated that his views were approved by the two remaining republicans on the committee. The conclusions of the two reports in regard to the specific persons under investigation are summarized in the press reports as follows:

MESSRS. ELLIOTT AND MOOREHOUSE—The majority report stated that they admitted making an arrangement which the majority regarded as in violation of the law and of sound public policy, but that there was no profit intended in it, and the Department had disciplined them too severely. The minority agreed as to the over-disciplining, but added that the Committee had no oversight of the Department's discipline, and that if such oversight were a fixed institution the Secretaries of Agriculture and their subordinates would become abject slaves to "red tape."

DEPARTMENT OF AGRICULTURE—The majority report called the department vacillating and lacking conception of the vast investment of millions of dollars in undertaking the reclamation of the Everglades, and said it constantly subordinated the inquiry to other work in which members of Congress were particularly interested, and finally abandoned it, after an expenditure of $11,107, without definite results. Its accounting system was deficient, and its discipline lacking. The minority upheld the Department.

SECY. OF AGRICULTURE WILSON—Falsely credited with authorship of the circular letter to which real estate promoters first objected, because of its cautionary nature. Promptly suppressed it, and refused publication of revised bulletin excerpts as a report on the Everglades. Minority reported that he did not abuse his legal discretion.

ASST. SECY. of AGRICULTURE HAYS—Criticized by the majority. The minority called the criticism unfair and unwarranted; that his interest in the possible sale of a North Carolina lake bed to Leigh Hunt and others was due to his well known public interest in the development of community country life.

J. O. WRIGHT (formerly a drainage engineer under Mr. Elliott, now engaged n private practice in drainage schemes in the South)—The majority said he "accepted fees and commissions whenever offered." His transactions were denounced as repugnant to a high sense of honor and integrity, which would justify dismissal if he were still in the Government service. The minority reported that no evidence was established that any financial statement indicating great gains from the Mattamuskeet, N. C., project were exhibited by Wright to Hays. Financial statement reaching committee was "faulty and ridiculous, and would have discredited the scheme at once."

Failure of Dam No. 26, Ohio River

The failure of the Chanoine wicket portion of U. S. Dam No. 26, on the Ohio River, on Aug. 8, 1912, as noted in our issue of last week, p. 234, is now under investigation by the Corps of Engineers, U. S. A. Pending the completion of this investigation, Gen. W. H. Bixby, Chief of Engineers, has issued a statement which we reprint below. Together with this statement we also reproduce from our issue of Mar. 4, 1909, p. 235, a detail of the Chanoine wicket in the navigable pass of Dam No. 37, on the Ohio River, a dam similar to No. 26 which failed. There may be minor differences in the design of the two wickets, but in general they are the same and the drawing of Dam No. 37 will help the reader to understand the nature of the failure of Dam No. 26.

Gen. Bixby's statement follows:

The following statement of conditions at Dam 26, Ohio River, where the navigable pass foundation failed on Aug. 8, 1912, is derived from the records now available. More conclusive data bearing upon the accident will probably be secured when the foundation is unwatered for reconstruction, which will be undertaken at once with the available funds, the unexpended balance of the appropriation for the dam being more than sufficient for this purpose.

The construction of Lock and Dam No. 26, Ohio River, was authorized by Congress in 1907, and five appropriations were made for it in successive years, aggregating a total of $1,200,000. The work was practically completed in 1911. It conforms to the general type in use on the Ohio River. The lock is 110x600 ft. The dam is movable, consisting of a navigable pass 600 ft. long, with Chanoine wickets, two bear-traps, each 91 ft., three bear-trap piers aggregating 38 ft. and a weir section 272 ft. long. The dam was first raised on July 16, 1912, but the pool was filled only within 2 ft. of the crest and there was a maximum head of only about 5.8 ft. of water. With full pool above the dam and low water below it there would be a maximum head of about 14.2 ft. On July 18, the dam was lowered on account of high water, and it was not raised again until Aug. 7. Beginning at 7:30 a.m., with the stage 4.9 ft. above low water, the pass was completely raised by noon, when the gages above and below the dam were 6.5 and 3.7 ft., respectively, above low water. One bear-trap was raised at 4 p.m., and the other at 8 p.m. The pass failed at 6:30 a.m., Aug. 8, 1912, when the upper pool was 0.8 ft. below the crest of the dam; the upper pool level being 13.4 ft. and the lower 2.7 ft. above low water, giving a head of 10.7 ft.

According to the eye witnesses, the first movement observed was that of several wickets in the middle part of the river, falling as if dropping to their lowered positions on the foundation. Immediately thereafter the wickets on each side began to move downstream, and apparently slightly to the right and left, away from the point of first failure, the failure gradually extending to the river wall and to the bear-trap pier. Of the wickets, 129 remained standing in their vertical position, and the other 21 dropped below the surface of the water. Three of these 21 were located afterward in a partly fallen position. Eighteen wickets are as yet unaccounted for, but it is thought they have probably fallen into their lowered positions on the foundation, and that none of them have moved as far downstream as the maximum movement of the wickets which remained standing. One wicket is badly tilted to one side as might happen from the failure of a horse box. The greatest movement downstream was 157 ft., occurring at a point 405 ft. from the river wall, measured to one wicket of a group of seven wickets which stand in a position oblique to their original one, the foundation at one side being pushed a little farther downstream than at the other.

The final positions of the shifted portions are all shown on the accompanying Figs. 1 and 2. It will be noticed therefrom that 32 wickets next to the bear-trap pier turned about the lower end of the concrete, where it abuts on the pier, and that in doing so the lower monolith of the pier was moved directly downstream about ½ in., the foundations of the bear-trap proper preventing it from moving sidewise. To relieve the current, 45 wickets next to the river wall were lowered before instructions not to do so were received at the dam, and it has not yet been ascertained if there was any motion downstream of the first 10 or 12 wickets next to the river wall, although the lockmaster feels certain there was little or none. The location of the wickets left standing were accurately determined with transit observations.

The sections of the dam in moving downstream were raised 2 or 3 ft. vertically as indicated by the soundings. These soundings when taken over the foundations are the elevation of the surface of the concrete, there being little or no gravel thereon. Soundings were taken to determine if the concrete was turned up or uneven, but it is apparently about horizontal. Soundings were taken with a pole.

A diver was sent to examine the foundations after the failure. It was possible for him to work only in certain localities due to the current. Starting at a point about 50 ft. from the bear-trap pier, he examined the foundation rock, where the pass had been, for about 30 ft. toward the lock. Some gravel had washed on to the rock, but in places the diver was able to reach the bottom of the upstream trench. At this point there are two trenches in the rock which had been filled in with the concrete of the foundation. None of the concrete was left in place. Examining downstream from the upper trench, the rock seemed to be horizontal on a level with the bottom of the trench, indicating that the rock had sheared off above that elevation. The rock was higher on the upper side of the trench, it being apparently intact. At a point about 180 ft. from the river wall, the upstream face of the foundation was comparatively free from gravel, and the diver was able to examine it for a distance of 30 to 40 ft. He found the concrete intact everywhere to the very bottom, indicating that it had moved as a whole.

In building the pass foundation, the surface rock was removed in most places for a depth of about 2 ft. This material

FIG. 1. VIEW LOOKING ACROSS OHIO RIVER DAM NO. 26, SHOWING DISPLACEMENT OF CHANOINE WICKETS
(Photograph taken Aug. 9.)

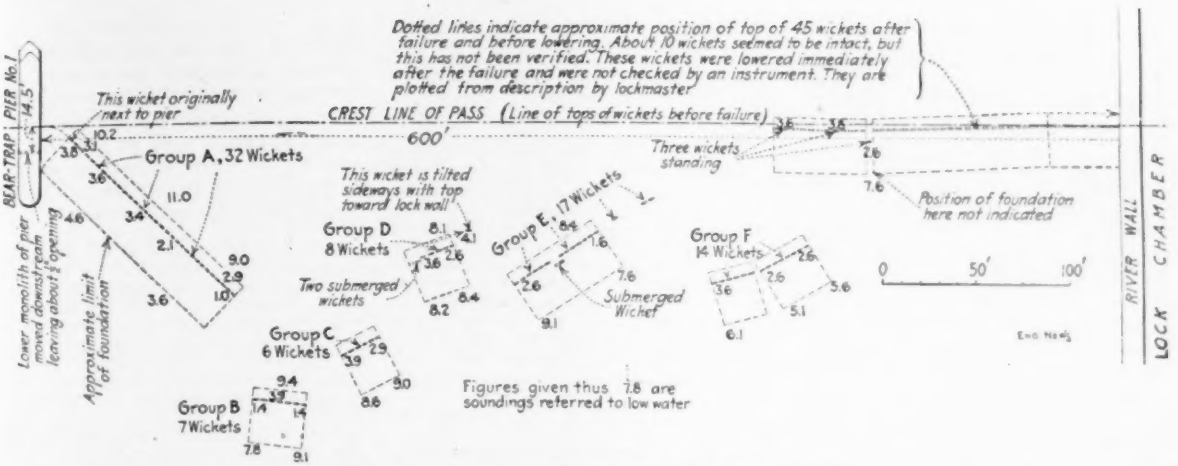

Dotted lines indicate approximate position of top of 45 wickets after failure and before lowering. About 10 wickets seemed to be intact, but this has not been verified. These wickets were lowered immediately after the failure and were not checked by an instrument. They are plotted from description by lockmaster
BEAR-TRAP PIER No.1
This wicket originally next to pier
CREST LINE OF PASS (Line of tops of wickets before failure)
600'
Group A, 32 Wickets
Three wickets standing
Position of foundation here not indicated
RIVER WALL
LOCK CHAMBER
This wicket is tilted sideways with top toward lock wall
Group D 8 Wickets
Group E, 17 Wickets
Group F 14 Wickets
Two submerged wickets
Submerged Wicket
Lower monolith of pier moved downstream leaving about 5' opening
Approximate limit of foundation
Group C 6 Wickets
Group B 7 Wickets
Figures given thus 7.8 are soundings referred to low water
0 50' 100'

FIG. 2. DIAGRAM OF DISPLACED WICKETS, DAM NO. 26

(Drawing shows location of tops of wickets on afternoon of Aug. 8. 84 wickets standing as shown above; 45 wickets were left standing near river wall after failure as indicated, but were lowered with maneuver boat afterward. The location of three submerged wickets is shown; 18 wickets are unaccounted for in this sketch, but are believed to be in a lowered position on account of their foundation, somewhere among those shown. The approximate position of the foundation is shown in some cases, but not all. It was determined as far as possible by soundings.)

was shale for practically the entire length of the pass, but seemed quite substantial after the top layers were removed. It did not give a ring when struck with a hammer such as hard granite or limestone gives, but it gave the impression of being solid and firm. The surface layers were loose and a piece of it ½ in. thick could easily be broken by the hand, but pieces excavated from a lower level in preparing the rock to receive the concrete could not be broken. When excavated the shale tended to break in horizontal layers, but this tendency disappeared in going downward and the excavated material came out in irregular pieces after the surface layers were removed. Borings were made into the foundation rock to test its character and the excavation was carried down to a depth supposed safe. In every case all loose or laminated material was removed, and the surface of the rock was rough, with irregularities several inches deep. In addition there was a shallow trench in the rock nearly everywhere and in some places two.

The original cost of the navigable pass was $61,091, exclusive of the cost of horses, props and wickets, which was $43,110. The movable parts will apparently be salvaged completely.

The design for the foundation called for a minimum depth of 2 ft. for the concrete slab, with as much additional depth at any place as might be required to reach sound bed rock. The actual depths varied from about 3 ft. to 4.6 ft. The assumptions upon which the design was based provided for a full pool above the dam with low water below it, and for upward pressures on the base amounting to 50% of those that would result from upper pool head at upstream side and low-water head at downstream side, and uniformly varying heads between these limits. The resultant line of pressure fell within the middle third.

All evidence so far available indicates that the concrete and all construction work in and above it were of good quality and that the character of the bed rock was not as good as was inferred from the borings and observations made during the progress of construction work.

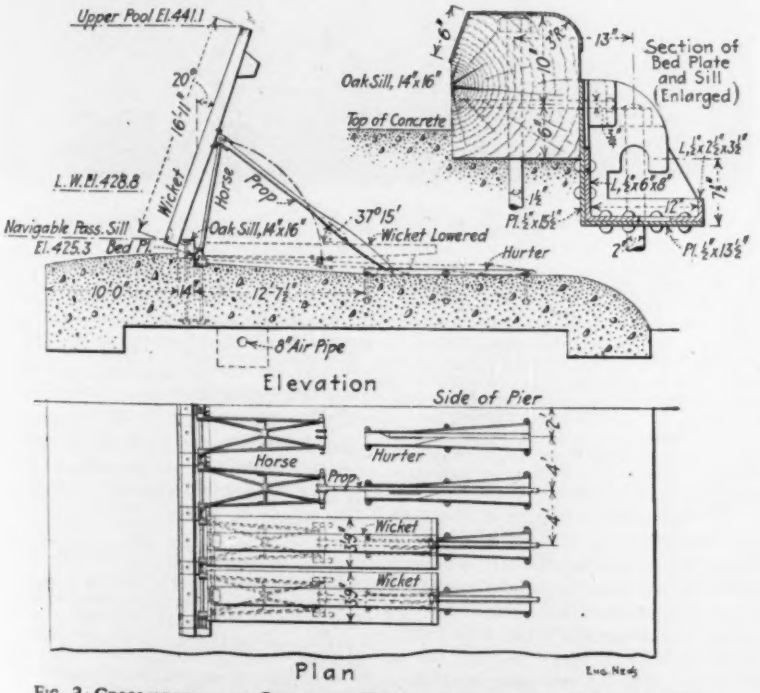


FIG. 3. CROSS-SECTION OF CHANOINE WICKET DAM FOR THE NAVIGABLE PASS OF DAM NO. 37

(Reproduced from Engineering News, Mar. 4, 1909, p. 235. This dam is similar in design though not in dimensions to Dam No. 26, which failed Aug. 8, 1912.)

An Electric Furnace of the Girod type is to be installed by the Bethlehem Steel Co., of South Bethlehem, Penn., for the manufacture of tool, armor, projectile and other high-grade special steels. It is expected that this will result in larger heats of the higher grades. The first furnace will have a melting capacity of 10 tons. It will be recalled that this type of furnace has one or a group of electrodes projecting from the roof into the crucible while the electrode of opposite polarity is of soft steel and embedded in the material of the hearth, being water-cooled at the bottom. The upper ends come in contact with the charge. The lining is of magnesite or dolomite brick and paste.

Leakage through the Expansion Joints of the Twin Peaks Reservoir, San Francisco, Calif.

The city of San Francisco has just completed an auxiliary high-pressure water system for fire protection in the congested district of the city. This system is to be supplied from water stored in the Twin Peaks reservoir, located at the intersection of 20th St. with the southerly extension of Cole St. at an elevation of about 755 ft. above sea level. The reservoir, which will be fed with fresh water pumped from wells sunk in its vicinity, is an oval-shaped depression in solid rock lined on the bottom and sides with concrete slabs and divided into two equal parts by a reinforced-concrete wall across its shortest diameter. As is shown in the halftone and in the accompanying drawings, the slabs on the bottom consist of 20x21-ft. rectangles and on the side slopes of trapezoids 10 ft. wide at the top, 5 ft. 3 in. wide at the bottom and 60 ft. long. The bottom slabs are of reinforced concrete, 6 in. deep and the side slabs 8 in. and 6 in. deep. They are separated both on the bottom and on the sides by expansion joints of a design described hereafter. The entire reservoir has a capacity for its 25-ft. depth of 10,000,000 gal.

One-half of the reservoir, as shown in Fig. 1, was filled to its full depth on May 12, 1912, and for a while apparently successfully held the water without leakage, but soon after a serious leakage was noted in this filled portion. The water was immediately drawn off and an investigation of the trouble made. As a result of this preliminary investigation, the Mayor of San Francisco appointed a Commission of engineers consisting of Messrs. M. M. O'Shaughnessy, Howard C. Holmes and W. R. Eckart to look into the cause of the leakage and to report thereon. For the full depth of 25 ft. it appeared that this leakage amounted to about 2,000,000 gal. of water per day.

The Commission met on June 18 and for several days thereafter and held hearings to listen to the testimony of the various engineers and contractors concerned and made extensive investigations of the condition of the reservoir and of the details of the design. It presented its final report to the Mayor on July 23.

The general findings of the Commission are that the leakage in the reservoir was through the expansion joints between the flooring slabs and that this leakage was due to improper design as well as careless construction of those joints.

In prefacing the report the Commission says:

> In connection with a reservoir of any magnitude it is expected and generally conceded that a certain amount of leakage and seepage will take place and within limits it is allowable. In the use of concrete for a reservoir lining it is necessary in order to make it impervious to make the concrete of a dense or rich mixture and to coat the same with a layer of properly applied cement plaster. A waterproofing compound is often added as an additional help in this connection. However, seepage is liable to occur either through the concrete itself or through expansion cracks which develop where the surface is large and is exposed to any material change in temperature. The seepage through concrete, though it may be considerable at the start with new construction, as a rule generally takes up through sedimentation. Cracks due to expansion, though they may also take up to some extent with sedimentation, are more often the source of considerable leakage.
>
> In order to prevent and minimize this in most instances concrete linings are reinforced by metal and divided into sections or blocks of various sizes, the expansion joints between the blocks being designed in many different types and forms and filled with various materials to permit the necessary expansion and contraction. To take care of the seepage through the reservoir and such ground water as there may be a suitable drainage system is generally provided. The question of the proper or limiting size of the concrete blocks, the shape and design of the expansion joints and the extent and location of the drains is largely one of engineering experience or judgment and concerning which there exists much diversity of opinion and different examples, successful and otherwise.
>
> The designing engineers of the reservoir evidently had in mind precisely the same considerations that are mentioned above in the report of the Commission, for it will be noted that their design provides such expansion joints and furthermore such drain pipes beneath the expansion joints as are suggested there. An additional consideration, however, governed the design of these joints, namely, the possibility of earthquake action on the reservoir. According to testimony before the Commission, this consideration influenced very materially the question of the sizes and shape of the concrete blocks and consequently the number and length of expansion joints. It also had its influence on the detail design of the joints and on the number and location of the subdrains. In this regard the Commission states:
>
> All of these matters as far as earthquakes are concerned may be stated to exist as entirely new engineering problems, the solution of the same having no fixed or definite engineering laws for guidance, and the success or failure of the resulting design would depend upon the nature and severity of the earthquakes it would have to withstand, and which cannot be foretold. It is, however, the opinion of the examining board that in the design of the slope lining it would have been preferable to have reduced the number of joints and to have provided horizontal expansion joints about midway up the slope, which would have helped to take care of certain slight expansion cracks which have appeared. Also, the drains should have been located adjacent to but not directly under the expansion joints, and the extent of the drains are excessive, being approximately 14% of the total under surface of the side slabs and 9% of the bottom slab surface.

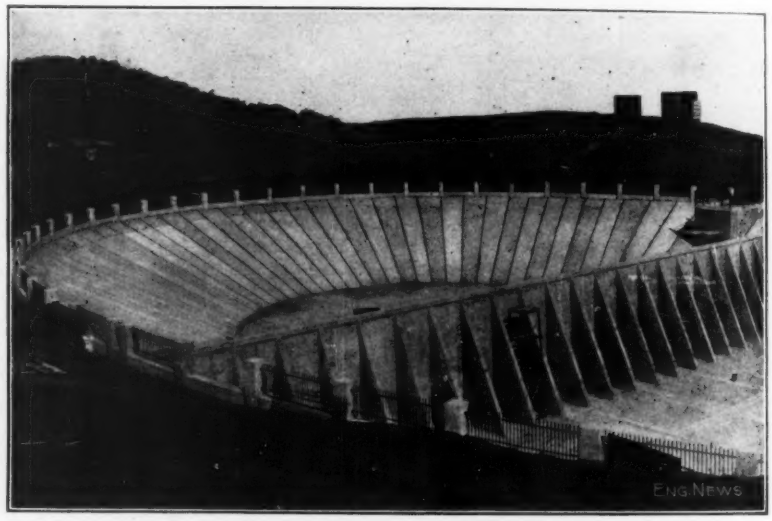


FIG. 1. PORTION OF TWIN PEAKS RESERVOIR, AUXILIARY WATER SUPPLY, SAN FRANCISCO

It is the opinion of the Commission that the leakage in the reservoir was directly through the expansion joints. These expansion joints are described in the report as follows:

> The general form of expansion joint as specified is reproduced in Fig. 3 and shows a space between the slabs tapering from ¾ in. at the top to ½ in. at the bottom filled with asphaltum, the bottom of the asphaltum resting on a loose fill of broken stone. This stone was to be such as would pass through a 2-in. screen and be rejected by a ½-in. screen.
>
> The asphalt before it was poured was to be heated to a temperature of from 250° to 300° F. and poured into the joints at that temperature. In order to harden

the asphalt used to fill joints on the sides 30% portland cement was to be mixed with the hot asphalt. The method to be used to obtain the proper shape of the joint was specified as follows:

Before the construction of the remaining block shall be commenced bevelled planks dressed ¾ x ¾ x 8 in. shall be placed between each block. After the concrete shall be thoroughly set the plank shall be removed and the remaining grooves run full of asphalt of the quality herein described and a watertight joint made.

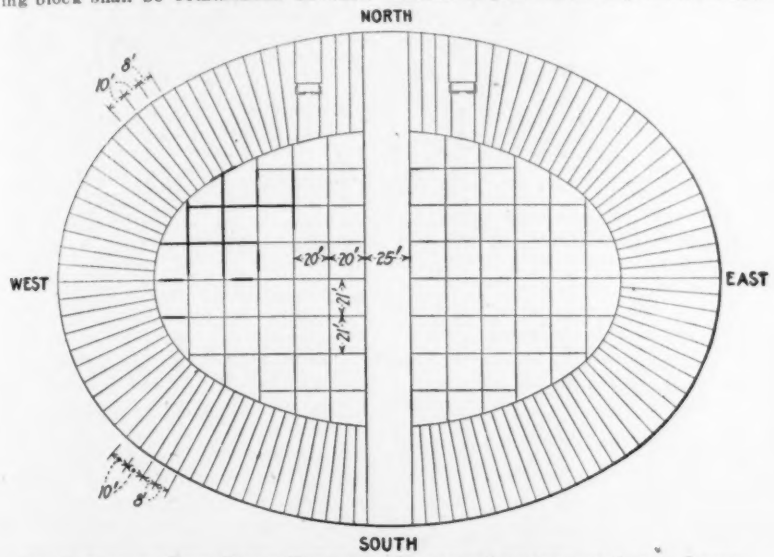


FIG. 2. PLAN OF TWIN PEAKS RESERVOIR, SHOWING LOCATION OF LEAKY JOINTS
(Heavy lines indicate leaky joints in bottom slab.)

It is the opinion of the Commission that the design of the specified joint was faulty inasmuch as the sole support of the asphalt in the joint and which had to resist pressure of the water in the reservoir was a loose rock fill. Any settling of this fill would allow the water pressure to force the soft and pliable asphalt out of the joints. Furthermore, the amount of the taper given the joint, namely, 1/16 in. in 6 in. or 8 in. on a side was so small as to be almost negligible and very difficult or impossible to work to in concrete construction.

The report then takes up the forms of expansion joints generally used in practice, all of which in the report are shown with some solid support, either an overlap of concrete or a mortise at the expansion filling, but remarks that these were not used on account of their impracticability for earthquake protection work. It then takes up in detail the construction of the joints, as follows:

Changes in Dimensions—From the weight of testimony taken it would appear that the dimensions of the joints were changed so as to increase the taper, making the joint ¾ in. at the top and ½ in. at the bottom. These dimensions are the same as those given on the drawings for the joints at the division wall. There are no records on file of the change in dimensions. In the contractors' statement they refer to a change having been made, but subsequently asked to withdraw this.

Fig. 4 shows the various dimensions of the joints as they were supposed to be from the testimony of the interested parties.

Oakum in the Joints—When it came time to pour the asphalt into the joints in order to prevent it at a temperature of 300°F. from running down into the rock fill a change was made and oakum was placed in the bottom of the joint to the depth of 1 in. This was only tamped in and not calked, the idea being to make a barrier to prevent the asphalt from flowing through into the rock fill and defeating the object of the drain pipes by closing them. The supervising engineer testified that it was his intention to allow the asphaltum to run into the rock fill. To quote him, "my idea in handling this thing was to take asphalt and pour it in there and I would have a layer of asphaltic concrete under there with the joints filled with asphalt. The hot asphalt was to be poured in and I thought we would have to get a lot of it in there until you could have a mass of asphaltic concrete."

If this was the intention it was not shown by the drawings and specifications and the engineer's ideas in reference thereto were not made known to those associated with him and immediately in charge of the construction. If an asphalt concrete were intended to be made beneath the joint and over the drain it would surely have been only common sense, good construction and economy to construct same while accessible, before the 6-in. concrete slabs were molded over it, rather than to rely on the doubtful method of injecting the liquid asphalt through the joint slots into the porous rock fill surrounding the drain with the probable consequence of choking up the latter and defeating any utility of the drainage system.

Rope on Side Slopes.—On the side slopes rope was dipped in asphalt and inserted in the top of the joint to prevent the asphalt from running out when poured. This rope was put in in 3-ft. sections, each section being poured before more rope was inserted. These joints are illustrated in Fig. 4.

Method of Shaping Joints—The specified method of using a ¾x-¾in. dressed board 8 in. deep to give the required shape to the joint was open to the objection that it would be impracticable to pull these strips out later owing to swelling, etc., and that there would have been danger of breaking them off in the slots, from which they would have to be cut out. The contractor proposed a substitute method which was accepted by the city engineer and which was used upon the construction. This method was to build first one slab, using wooden forms, then after this had properly set to remove the form, lay a steel plate against the rough concrete edge of the first slab, pour the concrete of the second slab and then with steel wedges driven between the first slab and the steel plate to obtain the proper taper.

We find that such reliance was placed upon this substitute method both by the contractor and inspectors that they did not deem it necessary to verify the results as the work proceeded; and we further find that no engineer or inspector of the city seemed to be impressed with the vital importance of measuring, checking and verifying the shapes of the joints as construction progressed or inspecting same before the oakum was placed in the bottom of the joint and the asphalt mixture was afterwards poured in them.

Actual Shapes of Joints—Upon opening up a number of joints chosen at random around the west compartment of the reservoir, it developed that the shape of the joint varied considerably from either that specified or the modifications. Joints were found with a taper either way, with the sides parallel and the axis of the joint 7° out of the vertical. Some of these various joints are illustrated in Fig. 5. [Many other examples are given in the original

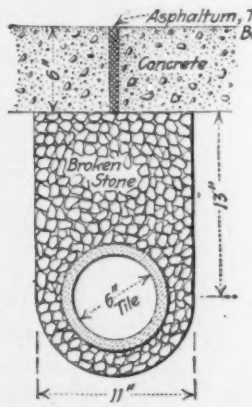


FIG. 3. DETAILS OF A BOTTOM EXPANSION JOINT AS GIVEN IN CONTRACT DRAWINGS

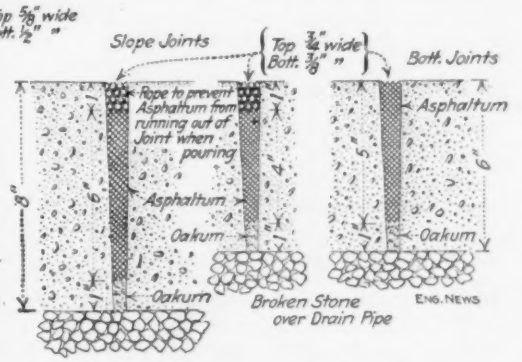


FIG. 4. DETAILS OF BOTTOM AND SLOPE EXPANSION JOINTS, EMBODYING ALL CHANGES MADE BY CITY ENGINEER'S OFFICE

report.—Editor.] The reason for this can be attributed to the method used in construction and affects the leakage question in two ways. (1) If the joint had been constructed of a uniform section and especially of the size finally adopted, there would have been decidedly less tendency for it to have been forced out under the 11 lb. per sq. in. water pressure. Where the shape conformed very closely to the dimensions in some of the joints, it took many blows with two heavy sledge hammers to drive the oakum through the slot into the fill, after which it drove easily. (2) It would have been possible to adopt methods of repair with more assurance and greater economy.

Adhesion Between Asphalt and Concrete.—As will be noted from the diagrams of some of the joints opened by the commission, Fig. 5, in none of those which had failed had the asphalt been completely forced through at the time the water was lowered and drawn out of the reservoir. The drop of the asphalt in the joints amounted to from 2 in. to 3 in., leaving a minimum of 3 in. of asphalt remaining in the 6 in. joint. With perfect adhesion between the concrete and asphalt, there should have been no leakage even with the settling of the asphalt. On removing the asphalt from the joints, it was noticed in many places that it pulled away clean from the concrete. Perfect adhesion would depend upon the nature of the asphalt mixture, the cleanliness of the concrete surfaces and their dryness. While no joint was found in which the asphalt had been completely forced out there is no question that, with the amount of settling which had taken place very generally in the rock fill, had the full water pressure been left on the joints, they would have eventually been forced out. This settling amounts to from 1 in. to 2½ in.

Asphalt in Slope Joints.—The asphalt in the side joints, being soft and pliable under the intense rays of the sun on hot days, when the water is down in the reservoir, tends to melt and run down out of the slots. This is prevented to some extent by the ropes which were left in the top of the slots. However, when the asphalt becomes fluid from the heat, the static pressure of the column of asphalt in the slot tends to force the rope out at the bottom and to allow the asphalt to partially run out. This occurred during the exceptionally hot days of last June, just after the leakage became such that the water was withdrawn from the reservoir.

Condition of Work.—From the testimony given and from the nature of the work performed in other parts of the reservoir, it would appear that the inspection had been carried out most thoroughly with the one exception where entire reliance seems to have been placed upon the method used for obtaining the proper shaped joint. The concrete of the work was good and dense, though possibly a trifle brittle.

Recommendations For Repair

The Commission made the following recommendations for the repair of the work:

The replacing of expansion joints to be made permanently tight will depend largely upon the success of supporting the pliable asphalt material used as a filler. This supporting element or ledge will have to be formed and built up step by step underneath the joint and edges of the slabs by a careful and painstaking process of (1) forming a proper cavity in the loose rock, and (2) filling same with grout packing consisting of cement, sand and hemp fiber, placed in position with specially formed tamping tools and allowed to harden as the work progresses. As the above work will now have to be done through the narrow slots existing between the slabs, without a possibility

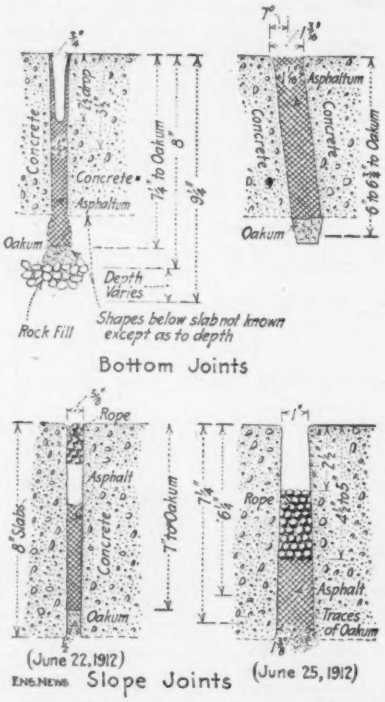


FIG. 5. SECTIONS THROUGH SOME JOINTS OPENED BY THE INVESTIGATING COMMISSION

of seeing under the same, except by reflected light, as it progresses, the integrity of the completed reinforcement will require perhaps a dead weight testing method during its construction, and a final test by refilling the reservoir after completion and subsequent calking of any inefficient work which may develop. The general method of procedure in placing this reinforcement should be (Fig. 6); first, remove all asphalt as far as practical, then with forming tools drive the remaining joint material through to at least 14 in. under the surface of the slabs, forming the first bed for grout at that distance in the rock fill. Over the oakum and asphalt, the cement, sand and hemp fiber should be tamped down, and if the ground appears very loose, one or more reinforcing rods can be worked in with the grout and packing. The remaining space up to the underside of the slabs should be carefully tamped and filled solid with cement and sand, and allowed to harden.

The supporting power of the fill, when the oakum is in, can be tested by a 1x2 in. steel bar having a dead weight on the upper end. If found to sustain the weight for a couple of hours, asphalt can be added to the joint as a final filler.

The asphalt filler should meet the general requirements, that it should be permanently elastic, and adhesive at all temperatures. Under the summer heat it should not soften sufficient to run out of the slope joints, nor should it crack in cold weather. A melting point not less than 220°F. and pliability at 32°F. would meet the latter.

The halftone in Fig. 1 is a view of the reservoir on May 12, 1912, immediately before the test filling of the west half of the reservoir was made. The division into two parts was made so that at least half of the supply might be available when the structure was in need of repair or cleaning. The dividing wall, a 1ft. thick reinforced-concrete vertical slab buttressed, as shown, on both sides, was waterproofed by coating with the sand-cement product of the "cement gun," the additional surface averaging ¼ in. at the top and increasing to ½ in. at the bottom. A mixture of one part portland cement and three parts graded sand with a small addition of hydrated lime was used over the entire surface of about 3200 sq.yd. When the water was pumped into one-half of the reservoir, a slight seepage took place through the dividing wall, but this soon ceased and the wall apparently became water-tight. The entire loss of water from the filled half was through the expansion joints.

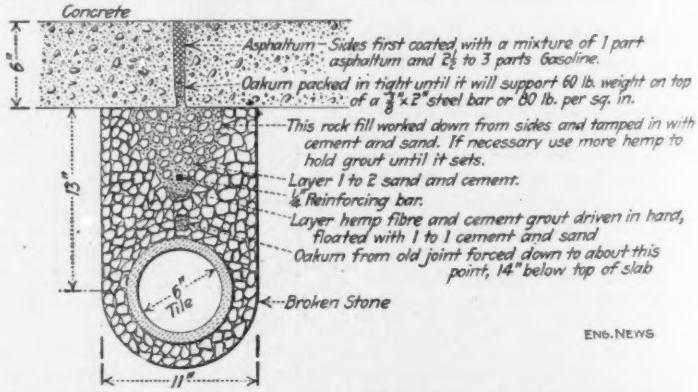

Concrete
6"
Asphaltum—Sides first coated with a mixture of 1 part asphaltum and 2½ to 3 parts Gasoline.
Oakum packed in tight until it will support 60 lb. weight on top of a ⅞"x2" steel bar or 80 lb. per sq. in.
This rock fill worked down from sides and tamped in with cement and sand. If necessary use more hemp to hold grout until it sets.
13"
Layer 1 to 2 sand and cement.
¼ Reinforcing bar.
Layer hemp fibre and cement grout driven in hard, floated with 1 to 1 cement and sand
Oakum from old joint forced down to about this point, 14" below top of slab
6" Tile
Broken Stone
ENG. NEWS
11"

FIG. 6. METHOD OF REPAIRING JOINTS SUGGESTED BY THE INVESTIGATING COMMISSION

The Twin Peaks Reservoir was designed by H. D. H. Connick, Assistant Engineer, under the supervision of Marsden Manson, City Engineer. The contract was executed by the Healy-Tibbetts Construction Co.

The Cost of Leaks in Water-Works Systems*

By Edward S. Cole†

Our nation-wide movement toward the conservation of natural resources has given to water-works men a new interest in the curtailment of water waste, especially during the last few years.

Water-works leakage in pumping plants includes: (a) plunger leakage, and (b) valve leakage.

All water-works plants, whether pumping or gravity, suffer loss of product in distribution by:

(a) Underground leakage from mains and services.

(b) House-fixture leakage from defective plumbing.

(c) Letting faucets run to obtain cool water in summer or to prevent freezing in winter.

(d) Stealing by large metered consumers.

Almost every water-works manager contends with some or all of the above classes of leakage and he must do one of two things, either allow the leaks to continue at whatever cost, or, spend time and money in stopping them. Evidently either alternative is expensive and the conscientious official wants to know which will cost him least.

In a pumping plant we should first know the pump-leakage. If tests show 15%, as at Chicago, and we assume that well made pumps should operate with a slippage under 5%, then there is a loss of pump capacity, steam and fuel of fully 10%, which, under Chicago conditions, costs $35,000 yearly for coal alone.

Probably the most serious loss involved in pump slippage is that of fire capacity, especially during hours of maximum draft. The neglect of pump-leakage has, in many cities, led to the purchase of additional machinery and boilers long before such extensions were really needed. In this way are incurred unnecessary fixed charges which may also be considered as part of the cost of leakage.

As for losses from the distribution system, we now doubt the old saying that "*leaks always show on the surface.*" Systematic water-waste surveys, conducted in Chicago, Memphis, Yonkers, Indianapolis, Washington and New York City have brought to light an immense number of underground leaks running continually into near-by sewers, without showing at the surface. In the city of Washington alone, in the past five years, a total of 30,000,000 gal. daily from about 3000 underground leaks were found chiefly in mains and service pipes, none of which showed above ground. A new water supply of this amount would have cost $5,000,000, plus extra operating expenses for the new plant, while the stopping of these leaks actually reduced the operating charges.

By the courtesy of Supt. W. A. McFarland, of the Washington Water Department, I am able to present the following analysis of 2600 underground leaks, found by him prior to Oct. 28, 1911:

ANALYSIS

1373 service pipe leaks	13,669,000	gal. daily
607 main joint leaks	8,076,000	" "
620 miscellaneous leaks	5,520,000	" "
Total 2600 leaks	27,265,000	" "

Without giving the entire list of 2600 underground leaks which I have, the following will serve as examples, including the largest leaks reported by Supt. McFarland.

	Gal.
G St. bet. 21st & 22d Sts. N. W. def. 4-in. plug	165,000
9th St. bet. F & G Sts. N. E. def. 6-in. joint	140,000
Washington Navy Yard, abandoned 2-in. service pipe	230,000
Capitol Grounds, blow-off valve open	737,000
C St. bet. 9th & 10th Sts. N. W. broken 6-in. main	302,000
9th St. & B St. N. E. (1st high service) def. 6-in. joint	141,000
21 1st St. N. E. def., 2-in. abandoned service pipe	150,000
5th & T Sts. N. W. 6-in. joint blown out	132,000
N. H. Ave. & Dupont Circle, N. W. 4 def. 6-in. joints	109,000
Alley bet. 12th & 13th Sts. & R. & S. Sts. N. W. blow-off on 4-in. main partly open	150,000
10th & S Sts. N. W. def. abandoned tap	135,203
2d & U Sts. N. W. def. 48-in. joint	180,000

Leakage also reduces the pressures through extra friction loss caused by forcing through the mains so much more water than reaches the consumers. In a great city where pressures are low, this extra friction loss may represent the difference between the first-floor and second-floor supply in thousands of homes. These families pay the penalty for neglected leakage and the cost is heavy.

The production cost of water in each particular plant is, of course, the principal basis for estimating the cost of leaks, but there are other elements of cost, which I wish to emphasize. The factors determining the cost of water as produced and distributed are too well known to be described here, involving the items of labor, supplies, general expense and repairs for each of the great divisions:

(a) Purification Works,

(b) Pumping Station,

(c) Distribution System.

In addition we should always include overhead charges, interest, sinking fund, depreciation and repairs.

We find a wide variation in the cost of water supply per thousand gallons, ranging from 3c. to 10c. in large plants, while in smaller plants less favorably situated, the cost may often run as high as 40c. or higher. Hence, it is useless to generalize or even to give the average cost of water in American cities.

We are familiar with the ordinary items of expense which have been mentioned, but there are other factors which affect the cost of leaks. To take a concrete example:

In the case of Chicago, the water-survey engineers have found that the works pump and distribute more than twice as much water as reaches the consumers. It is apparent, therefore, that the elimination of leakage would produce a threefold advantage:

1st. In saving about one-half the fuel.

2d. Increasing pressures by reduced friction loss.

3d. Producing reserve capacity for future growth, thus postponing needed extensions.

To anyone familiar with the rate of expenditure for extensions in a great city like Chicago, it is evident that this last item far exceeds all the others in determining the cost of leaks.

Still another basis of value was suggested by the manager of a large private water company last summer, who, during a period of drought, was at his wits end to know how to provide a water supply, not to mention adequate fire protection. At such times of "peak load" the real cost of leakage assumes extraordinary proportions.

As for stealing, it is comparatively easy to appraise the cost of a leak due to theft on the premises of large metered consumers. Such "leaks" are more common than many suppose, and, when detected, usually result in the payment of meter rates.

I have compiled from the latest available reports of 166 American cities the accompanying list of water-consumption figures, arranged in order of per capita consumption.

It is interesting to compare this table with the water consumption of British cities, in Table II, which I have taken from a recently published official directory. It should be understood that English cities use few meters, but depend upon the efficient Deacom system of district tests to control leakage.

Why is there this great variation among American cities and between American and English cities in the use of water? The per capita consumption in this country is almost invariably reported as the total use. We lump together indiscriminately, public use, business use and domestic use, which is obviously unfair if comparisons are to be made. In England, on the contrary, the water consumption is usually reported for domestic use as distinct from other uses.

It is evident that the water used for trade purposes in all British cities is small compared with the few available records of manufacturing use in American cities, but I believe that domestic consumption in English cities is not so much lower than in many of our own metered cities, if only domestic consumption were separated from all other use.

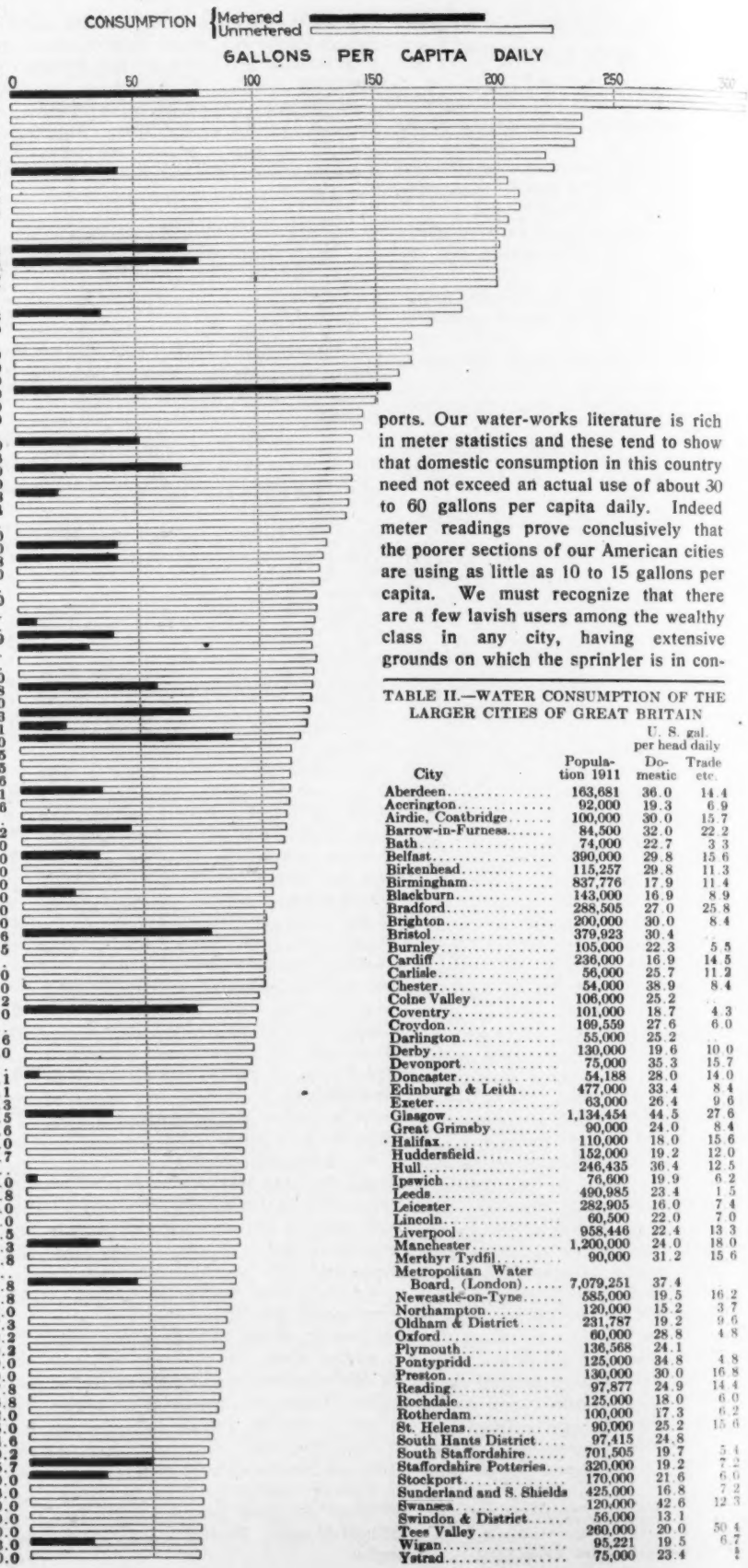
A movement should be started in this country to provide the much needed segregation of use in our water-works re-

*A paper read at the annual convention of the American Water Works Association, Louisville, Ky., June 6, 1912.

†220 Broadway, New York City.

TABLE I—WATER CONSUMPTION OF CITIES

City	Pop.	Date	Per cent. taps metered
Buffalo, N. Y.	423,700	'11	4.0
Salt Lake City	57,800	'06	2.0
Waco, Tex.	25,000	'12	..
St. John, N. B.	46,000	'08	3.2
Kingston, N. Y.	25,900	'08	..
Albany, N. Y.	100,200	'10	23.8
Chicago, Ill.	2,185,200	'11	6.0
Erie, Pa.	66,500	'10	2.5
Pittsburgh, Pa.	363,000	'06	10.0
Bridgeport, Conn.	82,000	'06	5.0
Philadelphia, Pa.	1,599,000	'10	..
Port Huron, Mich.	34,700	'10	..
Springfield, Ill.	25,000	'09	17.8
Grand Rapids, Mich.	81,000	'10	42.0
Mobile, Ala.	65,000	'12	10.0
Charleston, S. C.	25,000	'12	3.7
Peabody, Mass.	12,600	'09	..
Auburn, N. Y.	34,600	'11	5.3
Lafayette, Ind.	20,000	'10	9.0
Camden, N. J.	80,000	'08	..
Savannah, Ga.	65,000	'12	2.0
Augusta, Ga.	45,000	'12	5.0
Jersey City, N. J.	267,700	'10	9.0
Columbia, S. C.	27,000	'12	100.0
Jackson, Miss.	21,600	'12	15.0
Greensboro, N. C.	9,000	'12	6.0
Bangor, Me.	24,800	'07½'08	..
New London, Conn.	19,300	'10	15.0
Pawtucket, R. I.	50,000	'08	83.6
Lancaster, Pa.	45,000	'06	30.0
Binghamton, N. Y.	48,400	'10	29.0
Woburn, Mass.	15,200	'10	2.8
Atlantic City, N. J.	37,500	'06	78.4
Montreal, Can.	312,300	'09	..
San Antonio, Tex.	100,000	'12	16.0
Boston, Mass.	674,400	'10	20.0
Cincinnati, Ohio.	360,000	'10	32.8
Perth Amboy, N. J.	40,000	'10	29.0
New Brunswick, N. J.	23,300	'10	..
Meridian, Miss.	20,000	'12	14.0
Evansville, Ind.	69,600	'10	..
North Adams, Mass.	23,000	'09	..
Reading, Pa.	98,500	'08–'09	11.9
Baltimore, Md.	575,000	'09	..
Schenectady, N. Y.	72,800	'09	..
Nashville, Tenn.	100,000	'12	74.0
Springfield, Mass.	87,500	'10	60.8
Indianapolis, Ind.	150,000	'09	5.0
Wilmington, Del.	87,500	'10	34.3
Haverhill, Mass.	42,000	'10	17.1
Harrisburg, Pa.	64,100	'11	81.0
Kansas City, Mo.	250,000	'10–'11	44.5
Milwaukee, Wis.	385,000	'11	81.5
St. Louis, Mo.	687,000	'10	6.6
Louisville, Ky.	201,600	'10	8.1
Met. Water Board	1,022,200	'10	37.6
Pittsfield, Mass.	32,000	'10	..
Newark, N. J.	331,000	'09	49.2
Bayonne, N. J.	55,500	'10	99.0
Holyoke, Mass.	56,900	'10	9.0
Cambridge, Mass.	100,000	'10	38.0
Knoxville, Tenn.	60,000	'12	42.0
Plymouth, Mass.	12,100	'10	94.0
Richmond, Va.	127,600	'12	69.0
Peoria, Ill.	73,000	'12	36.0
Cleveland, Ohio.	516,000	'08	93.6
Macon, Ga.	50,000	'12	26.5
New York City	4,910,000	'11	..
Austin, Texas	35,000	'12	100.0
Atlanta, Ga.	150,000	'12	100.0
Toronto, Ont.	360,000	'10	4.2
Yonkers, N. Y.	77,500	'09	100.0
Memphis, Tenn.	135,000	'12	..
Holland, Mich.	10,000	'10	96.6
Andover, Mass.	7,000	'07	80.0
Dallas, Tex.	93,000	'12	..
East Orange, N. J.	35,700	'10	18.1
Beverly, Mass.	18,600	'10	4.1
Stoneham, Mass.	7,100	'10	43.3
Poughkeepsie, N. Y.	27,900	'08	89.5
Syracuse, N. Y.	137,200	'08	87.6
Jamestown, N. Y.	31,200	'10	51.0
Salem, Mass.	43,600	'10	89.7
Brookline, Mass.	27,700	'10	..
Waltham, Mass.	27,700	'10	12.0
South Bend, Ind.	53,600	'10	17.8
Quincy, Mass.	32,800	'10	36.0
Utica, N. Y.	74,400	'10	100.0
Duluth, Minn.	78,400	'10	51.5
Chelsea, Mass.	32,500	'10	64.3
Hartford, Conn.	85,000	'09	98.8
Bridgeton, N. J.	14,200	'10	..
New Bedford, Mass.	92,000	'10	47.8
Arlington, Mass.	11,200	'10	62.8
Spartanburg, S. C.	12,000	'12	37.0
Marion, Ind.	19,300	'10	17.3
Rockford, Ill.	45,500	'10	49.2
Fitchburg, Mass.	37,000	'10	70.2
Columbus, Ohio.	200,000	'09	80.0
New Orleans, La.	200,000	'12	100.0
Somerville, Mass.	77,600	'10	47.8
Lexington, Mass.	4,400	'10	56.8
Everett, Mass.	33,700	'10	22.0
Washington, D. C.	331,000	'10	25.0
Dayton, Ohio.	116,500	'09	74.6
Providence, R. I.	224,300	'11	89.2
Worcester, Mass.	149,500	'10	65.7
Lynn, Mass.	85,300	'08	40.0
Revere, Mass.	18,500	'10	26.0
Manistee, Mich.	14,000	'09½'10	9.0
Galveston, Tex.	40,000	'12	99.0
Hamilton, Ohio.	35,200	'09	60.0
Taunton, Mass.	32,500	'11	53.0
Watertown, Mass.	12,900	'10	100.0



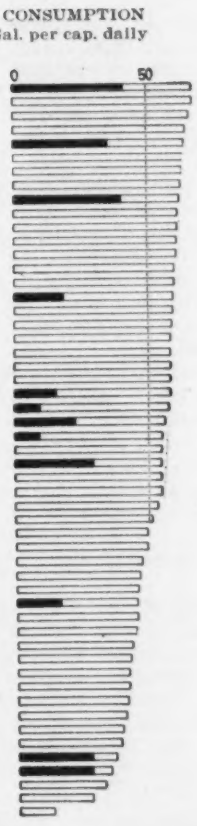
ports. Our water-works literature is rich in meter statistics and these tend to show that domestic consumption in this country need not exceed an actual use of about 30 to 60 gallons per capita daily. Indeed meter readings prove conclusively that the poorer sections of our American cities are using as little as 10 to 15 gallons per capita. We must recognize that there are a few lavish users among the wealthy class in any city, having extensive grounds on which the sprinkler is in con-

TABLE II.—WATER CONSUMPTION OF THE LARGER CITIES OF GREAT BRITAIN

City	Population 1911	U. S. gal. per head daily: Domestic	Trade etc.
Aberdeen	163,681	36.0	14.4
Accrington	92,000	19.3	6.9
Airdie, Coatbridge	100,000	30.0	15.7
Barrow-in-Furness	84,500	32.0	22.2
Bath	74,000	22.7	3.3
Belfast	390,000	29.8	15.6
Birkenhead	115,257	29.8	11.3
Birmingham	837,776	17.9	11.4
Blackburn	143,000	16.9	8.9
Bradford	288,505	27.0	25.8
Brighton	200,000	30.0	8.4
Bristol	379,923	30.4	..
Burnley	105,000	22.3	5.5
Cardiff	236,000	16.9	14.5
Carlisle	56,000	25.7	11.2
Chester	54,000	38.9	8.4
Colne Valley	106,000	25.2	..
Coventry	101,000	18.7	4.3
Croydon	169,559	27.6	6.0
Darlington	55,000	25.2	..
Derby	130,000	19.6	10.0
Devonport	75,000	35.3	15.7
Doncaster	54,188	28.0	14.0
Edinburgh & Leith	477,000	33.4	8.4
Exeter	63,000	26.4	9.6
Glasgow	1,134,454	44.5	27.6
Great Grimsby	90,000	24.0	8.4
Halifax	110,000	18.0	15.6
Huddersfield	152,000	19.2	12.0
Hull	246,435	36.4	12.5
Ipswich	76,600	19.9	6.2
Leeds	490,985	23.4	1.5
Leicester	282,905	16.0	7.4
Lincoln	60,500	22.0	7.0
Liverpool	958,446	22.4	13.3
Manchester	1,200,000	24.0	18.0
Merthyr Tydfil	90,000	31.2	15.6
Metropolitan Water Board, (London)	7,079,251	37.4	..
Newcastle-on-Tyne	585,000	19.5	16.2
Northampton	120,000	15.2	3.7
Oldham & District	231,787	19.2	9.6
Oxford	60,000	28.8	4.8
Plymouth	136,568	24.1	..
Pontypridd	125,000	34.8	4.8
Preston	130,000	30.0	16.8
Reading	97,877	24.9	14.4
Rochdale	125,000	18.0	6.0
Rotherdam	100,000	17.3	6.2
St. Helens	90,000	25.2	15.6
South Hants District	97,415	24.8	..
South Staffordshire	701,505	19.7	5.4
Staffordshire Potteries	320,000	19.2	7.2
Stockport	170,000	21.6	6.0
Sunderland and S. Shields	425,000	16.8	7.2
Swansea	120,000	42.6	12.3
Swindon & District	56,000	13.1	..
Tees Valley	260,000	20.0	50.4
Wigan	95,221	19.5	6.7
Ystrad	75,000	23.4	..

TABLE 1 (Continued)

City	Pop.	Date	Per cent. taps metered
Battle Creek, Mich.	27,000	'11	96.0
Toledo, Ohio	195,000	'11	86.0
Jacksonville, Fla.	58,000	'09	70.0
Melrose, Mass.	15,700	'10	100.0
Framingham, Mass.	10,200	'08	77.0
Chicopee, Mass.	25,400	'10	...
Winthrop, Mass.	10,200	'10	95.9
Fort Worth, Tex.	80,000	'12	100.0
Newton, Mass.	39,600	'10	88.6
Fort Wayne, Ind.	63,800	'08	34.5
St. Paul, Minn.	214,700	'10	51.0
Medford, Mass.	23,300	'10	94.4
Covington, Ky.	53,200	'10	100.0
Minneapolis, Minn.	315,000	'09	78.8
Tampa, Fla.	50,000	'12	25.0
Newport, Ky.	35,000	'10	31.0
Topeka, Can.	43,600	'10	68.0
Belmont, Mass.	5,600	'10	100.0
Swampscott, Mass.	6,900	'10	99.1
Westerly, R. I.	12,000	'09	...
Nahant, Mass.	2,100	'10	42.7
Norwood, Mass.		'05	...
Natick, Mass.	9,600	'09	65.0
Gardner, Mass.	11,300	'09	7.0
Madison, Wis.	26,900	'09	99.0
Gloucester, Mass.	23,000	'09	5.0
Charlotte, N. C.	20,000	'12	100.0
Lowell, Mass.	96,300	'08	75.3
Aurora, Ill.	33,000	'09	...
Houston, Tex.	105,000	'12	89.0
Attleboro, Mass.	17,500	'10	100.0
Kalamazoo, Mich.	39,400	'10	96.6
Ware, Mass.	9,000	'09	93.0
Fall River, Mass.	114,300	'09	98.8
Wellesley, Mass.	7,000	'09	100.0
Franklin, N. H.	4,800	'08	100.0
Lawrence, Mass.	82,000	'09	90.0
Marlborough, Mass.	13,800	'09	65.
Sioux City, Iowa	25,200	'09	100.0
Malden, Mass.	44,700	'10	96.3
Quincy, Ill.	36,500	'10	58.0
Dover, N. H.	13,000	'11	73.0
Methuen, Mass.	12,000	'11	75.2
Lexington, Ky.	45,000	'10	56.8
Danville, Va.	19,000	'08	95.2
Milton, Mass.	7,900	'10	100.0
Middleboro, Mass.	7,000	'05	...
Concord, N. H.	21,500	'10	57.2
Brockton, Mass.	66,000	'10	99.4
Woonsocket, R. I.	42,700	'10	87.0
Reading, Mass.	5,700	'09	97.0
Auburn, Me.	15,000	'10-'11	...
Winchendon, Mass.	7,200	'09	85.0



tinuous operation and having an elaborate supply of house fixtures, but it must be remembered that this extravagant class is extremely limited in number and probably has little effect upon the average water consumption of our large cities. Of course, we must expect to find greater economy in the older countries of Europe, which long ago felt the pinch of a diminishing water supply, such as are likely to suffer in our turn when population here has become as dense.

Do not let us deceive ourselves by the use of unfair statistics. It is absolutely necessary to know how we compare in domestic use, after deducting water for all other purposes. I would make a most earnest plea that water-works men report even approximately, such figures as will help us separate domestic from business use of water. This data would be valuable to every water-works man, giving him for the first time the means for demonstrating efficient management and for pointing the way to increased economy through intelligent comparison.

According to such figures as we have, there are 20 American cities showing a per capita daily use for business purposes of from 3 to 70 gallons, most of them using from about 30 to 40 gallons. With this allowance in mind, it is interesting to examine our American list, and note that many domestic rates comparable with those of the English cities would remain, after deducting this amount of business use from the totals reported. Of course, any such comparisons must be made with care, for business use may vary from nothing in the residential town to a large part of the entire supply in manufacturing centers.

This discussion of reasonable per capita consumption is presented merely as a basis on which to determine whether or not there are excessive leaks in a given city. Without some such basis, many a city is operating wastefully without knowing the truth.

Metered cities are fortunately situated in being able to make such an analysis, and it should be an easy matter for them to arrive at this necessary basis for comparison. In the fully metered city it is possible to compare the total pumpage or supply with the total registration of all meters. The amount remaining "unaccounted for" is, of course, the most reliable criterion of leakage which it is possible to obtain. Occasionally we find a city with practically every service metered, but accounting for only 50% or 60% of its total supply. The manager of such a plant should entertain no delusion as to the efficiency of his administration. Either he has underground leakage or there is stealing from his mains, and the one costs as much as the other. The question, does it pay to stop leaks? answers itself.

Recommendations for an Intercepting Sewer and Imhoff Tank at Albany, N. Y.

The treatment of the dry-weather flow of the sewage of Albany, N. Y., by means of grit chambers and Imhoff tanks has been recommended in a report by Hering & Gregory, of New York City, addressed to Walter Greenalch, Commissioner of Public Work, Albany. To carry out this recommendation an intercepting sewer would be required together with a pumping station at the disposal works to pump all of the intercepted sewage and also a pumping station to lift the sewage of a small portion of the city known as North Albany. The Imhoff tanks recommended would have a daily capacity of 30,000,000 gal. It is believed that this capacity would be sufficient to meet the needs of the city for many years to come, provided that steps are taken to curtail the very high water consumption that prevails in Albany.

Although the population of Albany has increased only from 94,923, as shown by the census of 1890, to 100,253 in 1910, the water consumption for the corresponding years has increased from 13,176,000 gal. to 22,390,000 gal. The per capita water consumption in 1890 was 139, in 1910, 223 and in 1911 it had increased still further to 242. Prior to 1894 no meters were in use. In that year 264 were installed and at the close of 1895 there were a total of 1181 in use. In 1911 the number of meters was 4630, or 26% of the services. In view of this very high water consumption and the rapid increase which has taken place within the period stated, it is not at all surprising that Messrs. Hering & Gregory strongly advised "that all water services in the City of Albany be metered at the earliest possible date."

The object of the sewage-treatment work recommended in the report is the removal of "suspended matters which would float on the surface of the water and be displeasing to the eye or which would settle on the bottom and banks of the river and form objectionable sludge deposits."

Below Albany, it may be explained, the nearest city is Hudson, which is 30 miles from Albany.

The drainage area of the Hudson River at Albany is about 8200 square miles. The urban population on the river above Albany within ten miles of that city totaled about 128,000 in 1910. The corresponding figures within distances of 50, 70, 100 and 133 miles of the city were 290,000, 382,000, 436,000 and 542,000, respectively. The last named figure represents the total urban population on the entire drainage area of the Hudson River and its tributaries in 1910.

As nearly as can be ascertained*, the minimum monthly flow of the Hudson River at Albany was 1590 cu.ft. per sec. in September, 1908. The minimum day for the month just named was 1132 cu.ft. per sec. Quoting now from the report:

> Assuming that, under the river conditions prevailing at Albany, it would require a flow of 4 cu.ft. per sec. to inoffensively dilute the sewage from a population of 1000, then an average minimum flow of 1590 cu.ft. per sec. should suffice for a population of about 398,000, while a minimum flow of only 1132 cu.ft. per sec. would properly dilute the sewage of but 283,000 persons.
>
> It is therefore apparent that the combined population of the City of Albany and the municipalities located on the river and its tributaries above the city is approaching a point where it may, at times of very low water, be expected to give rise to objectionable conditions.

Analyses to determine the dissolved oxygen in Hudson River water near Albany, N. Y., were made in 1911 for Hering & Gregory by George E. Willcomb, Chemist and Bacteriologist of the Albany Water Filtration Plant. Two paragraphs may be quoted from the report as follows:

> It appears from these observations that the greatest depletion of oxygen in the river water is usually near the bottom, and this is generally due to the exhaustion caused by the deposited sludge. It also appears that in a number of cases the oxygen has been more exhausted near the surface than below, which may have been partly due to floating particles of organic matter. These two facts indicate the desirability of removing from the sewage not only the lighter suspended matters which are likely to float on the surface of the water, but also the heavier suspended matters which tend to settle and form sludge deposits on the river bottom.
>
> Mr. Willcomb's observations also show that the entrance of sewage into the river at and above Albany materially reduces the dissolved oxygen content of the water. During very low flow in the river, such as occurred in August, 1911, the pollution of the water is evident above the city of Albany, opposite the water-works intake, and increases to an objectionable degree opposite and immediately below the city; but further down stream the observations indicate the effects of a certain degree of self-purification of the water.

The proposed intercepting sewer would range in size from 2 ft. to 5½ ft. in diameter. At its lower end it would have an estimated capacity of 60,000,000 per 24 hr. Automatic regulators would be provided so that the storm-water flow would be discharged directly into the river instead of going through the intercepting sewer.

The site chosen for the disposal works is on Westerlo Island in the township of Bethlehem, opposite the extreme southeast corner of the City of Albany. This island is separated from the mainland by water known as Island Creek. On this island it appears the city has bought 75.1 acres of land for sewage-disposal purposes.

The sewage would be pumped from the lower end of the outlet sewer to 16 Imhoff settling tanks, each 33 ft. wide, 98 ft. long and 27 ft. 2½ in. deep from the water line to the bottom of the sludge chamber. There would be four groups or sets of tanks, with four tanks in each group. With all 16 tanks in use there would be an average detention period of three hours in the tanks when they were running at their nominal capacity of 30,000,000 gal. per day.

The plans provide for 32 sludge-drying beds with a total area of 66,560 sq.ft. Each bed would consist of layers of graded gravel or broken stone with the coarsest material at the bottom. The average thickness of the bed would be about 12 in. The top of the beds would be covered with a thin layer of coarse sand. The beds would be underdrained with 3-in. drain tiles, laid in valleys. The small drain tiles would connect with an 8-in. main drain. The work could be easily extended as occasion demanded, both in total capacity and as regards degree of purification. The topography would permit of the addition of sprinkling filters if these should be considered desirable later on.

The estimated cost of the sewage-treatment works and the few hundred feet of sewer to connect them with the intercepting sewer is $306,400. Contract drawings for the treatment works have been prepared by Hering & Gregory, and will be submitted by the City of Albany to the State Commissioner of Health for approval, as required by law.

*That is, by estimating the flow from the 260 miles of drainage area between Albany and the urban drainage area and adding it to the flow at the gaging point.—Ed.

A Derailment occurred on Aug. 12 in the Park Avenue Tunnel at 55th St., New York City. The electric locomotive of a New York, New Haven & Hartford express, running at six miles an hour, left the rails, dragging with it the baggage car. The third rail was short-circuited and a blaze started, but this was put out shortly and caused little damage.

The Railroad Bridge near Keechelus, Wash., collapsed on Aug. 12, under the Olympian Limited on the Chicago, Milwaukee & Puget Sound Ry. The train was a double-header and both engineers and both firemen were killed. Among the passengers, there was one killed and several injured. No definite cause for the failure has been assigned.

A Heavy Repair Derrick fell through the Wanaque River bridge on the Erie R.R., near Ringwood Junction, N. J., on Aug. 13, and nine of the repair gang were injured. One of the bridge supports had been removed, preparatory to placing a new one, when the whole structure gave way.

A Gas Explosion in the coal bins set fire to the power plant of the street railway company, at Jamestown, N. Y., on Aug. 10, and tied up the traction system completely. The fire was confined to the boiler house and the damage is placed at $25,000.

A Lighted Candle set fire to an oil tank in the Santa Fé R.R. shops, at Cleburne, Texas, on Aug. 12, and the flames spread to the car sheds and lumber yards, causing a $250,000 loss.

Fast Passenger Train No. 6, on the line of the St. Louis & San Francisco R.R. Co., was derailed on Aug. 11, near Rogers, Ark., killing the fireman and injuring 14 of the crew and five passengers. No cause for the accident has been found.

A Washout on the line of the Chicago & North Western Ry. Co., six miles east of Pierre, S. D., caused the wreck of a passenger train on Aug. 12. The fireman was killed and the engineer badly scalded, but no passengers were seriously injured. The engineer claimed that the tracks were apparently in good condition right up to the time of the accident and it is probable that a short section of road-bed was washed out leaving the tracks to all appearances safe, but without any support.

A Sunken Scow, which was being filled with air preparatory to raising it, suddenly turned over and caught beneath it two divers who had gone down to inspect the work. One was rescued and will recover, but the other diver was drowned. The accident occurred on Lake Erie, four miles southeast of Fort Burwell, Ont., on Aug. 15.

A Spreading Rail is blamed for the wrecking of the Pennsylvania 18-hour flyer, between New York and Chicago, near Middle Point, Ohio, on Aug. 17. The train, consisting of a locomotive and six cars, was traveling at a speed of 60 miles an hour when the accident happened. Every car left the rails, but only three passengers were injured, one seriously.

The Marmora Earthquake death roll has reached 3000, with 6000 injured, according to the latest reports from the stricken district. Minor quakes are occurring daily, and the surviving inhabitants of the district are too stunned to help themselves.

In Collision with an Iceberg near the Straits of Belle Isle, on Aug. 12, the Allan liner "Corsican" was slightly damaged above the water line, but was able to continue on her voyage from Montreal to Liverpool. The liner was going at reduced speed at the time of the accident and there were two lookouts posted, but dense fog rendered these precautions ineffectual.

The Good Roads Movement is blamed for two recent derailments on the Chicago, Burlington & Quincy R.R. lines. In each case the flange ways at a road crossing had been filled by the action of scrapers and road grading machines, and the precaution had not been taken to remove this filling of dirt and stones. Through the medium of a safety department, the railroad is making an effort to keep all flange ways clear.

The Trespassers Killed on the Pennsylvania R.R. lines, in 1911, numbered 527, against 916 killed in 1907. This reduction has been due to the organization of a railroad police department, which aims both to guard against accidents and to protect the railroad property. The Pennsylvania R.R. is endeavoring to secure the coöperation of municipal authorities in preventing the use of its private right of way as a public thoroughfare. This form of trespassing in industrial centers is claimed to be the cause of a large number of fatal accidents.

Panama Canal Excavation during July totaled 2,633,437 cu.yd., a daily average of 101,286 cu.yd. for each of the 26 work-

ing days. The rainfall for the month was 10.92 in. The amount of concrete laid in July was 87,485 cu.yd., and 369,838 cu.yd. of fill were placed in dams.

The Second Simplon Tunnel is to be built by the Government direct instead of by contract, according to the decision of the managing board of the Swiss Federal Railways, on July 19, 1912. The railway authorities had proposed to the board to let a contract, on bids received, but the board, after lengthy discussion, decided to undertake the work under its own management. The same question came up a year or more ago when the construction of the Hauenstein tunnel was undertaken, but in that case the decision was in favor of doing the work by contract. The second Simplon tunnel will be the first large governmental work in Switzerland to be done under direct management.

A Centennial Celebration has just taken place at Essen, Germany, in honor of the founding of the Friedrich Krupp Establishments, in 1812, and of the birth, in the same year, of Alfred Krupp, to whose progressiveness and tireless energy the enterprise owes the foundations for its present prosperity. The early history of the Krupp works was one of alternate success and failure. Repeated appeals to the state for aid in enlarging the plant and in providing adequate equipment, were unfruitful, but in each case some way out of the difficulty was found, and, from a single factory in an Essen of 4000 inhabitants, there has grown in a century, an industry with buildings covering 232 acres, in an Essen of 300,000 inhabitants. Throughout this period the Krupp family has maintained its ownership and control of the works which bear its name. An extended and interesting description of the various stages in the growth of the Krupp works is given in London "Engineering," for Aug. 9, 1912.

Personals

Mr. J. B. Logan, formerly an engineer with the Maryland State Roads Commission, has been appointed City Engineer of Annapolis, Md.

Mr. A. V. Saph, Assoc. M. Am. Soc. C. E., has resigned as Assistant State Engineer with the Board of Harbor Commissioners, San Francisco, Calif.

Prof. William J. Carrel, of the department of civil engineering, State University of Kentucky, has been appointed Bridge Engineer of the Kentucky State Highway Department.

Mr. C. A. Stelle, Division Engineer of the Wheeling & Lake Erie R.R., at Canton, Ohio, has been appointed Division Engineer of the Chicago & Alton R.R. at Bloomington, Ill.

Mr. W. H. Cunningham, of the firm of Cunningham & Carter, Consulting Engineers, of Ashland, Ky., and Huntington, W. Va., has been appointed Assistant State Geologist of Kentucky.

Mr. C. J. Rist, Supervisor at Akron, Ohio, of the Erie R.R., has been promoted to be Division Engineer, with headquarters at Huntington, Ind., succeeding Mr. A. Swartz, resigned.

Mr. J. Grant Code, formerly Superintendent of the Toledo division of the Wheeling & Lake Erie R.R., has been promoted to be General Superintendent with headquarters at Cleveland, Ohio.

Mr. H. G. Burham, formerly Chemist and Engineer of Tests of the Buffalo, Rochester & Pittsburgh R.R., at Du Bois, Penn., is now Engineer of Tests of the Northern Pacific Ry., at St. Paul, Minn.

Mr. Philip Carroll, Engineer of Maintenance-of-Way of the Missouri Pacific Ry. system, has been promoted to be Assistant General Superintendent of the Southern district of the St. Louis, Iron Mountain & Southern Ry., with office at Little Rock, Ark.

Mr. J. A. Heaman, Assoc. M. Can. Soc. C. E., Division Engineer of the Grand Trunk Pacific Ry., at Fitzhugh, Alta., has been promoted to be Assistant to the Chief Engineer, with headquarters at Winnipeg, Man. Mr. Heaman is succeeded as Division Engineer by Mr. F. J. George.

Mr. Walter N. Polakov, an efficiency engineer, formerly associated with H. L. Gantt and Harrington Emerson, and an expert consulting engineer for the Board of Estimate and Apportionment of the City of New York, is now associated with the firm of Day & Zimmermann, Philadelphia, Penn.

Mr. G. E. Buckley, for a number of years Assistant Engineer of the Southern Ry., at Charlotte, N. C., has been appointed Engineer of Maintenance-of-Way of the Western district, at St. Louis, Mo., succeeding Mr. Edward Gray, M. Am. Soc. C. E., whose resignation was noted in our issue of Aug. 1.

Mr. Sidney L. Cole, of Fort Madison, Iowa, formerly Superintendent of the Pulaski Gas Light Co., Little Rock, Ark., has been appointed Manager of the Wakefield, Mass., municipal gas and electric plants. Mr. Cole graduated in mechanical engineering at Massachusetts Institute of Technology in 1905.

Mr. Theodore P. Shonts has resigned as President of the Toledo, St. Louis & Western R.R. because his duties as President of the Interborough Rapid Transit Co., New York City, now require all his time. He is succeeded as President of the Toledo, St. Louis & Western R.R. by Mr. W. L. Ross, former Vice-President.

Messrs. T. Wilson Battin and A. L. Osgood have given over their private engineering practice to the Civic Service Corporation, Philadelphia, Penn., of which Mr. G. Henry Stetson is President, Mr. T. Wilson Battin, Vice-President and Secretary, Mr. J. Lee Patton, Treasurer, and Mr. A. L. Osgood, General Manager.

Ewing & Stone Co., Civil and Consulting Engineers, 1742 Monadnock Block, Chicago, Ill., announce the change in the firm name to the Central Engineering Bureau, with Mr. Frank L. Stone, President, Mr. Edwin Hancock, Vice-President, and Mrs. Mary E. Ewing, widow of the late William B. Ewing, M. Am. Soc. C. E., Secretary.

Mr. Charles T. Salisbury, formerly a train loading inspector of the Chicago, Burlington & Quincy R.R., has been appointed Train Rule Examiner, a newly created position, the duties of which will be the examination of trainmen on rules and inspection as to how the rules are being complied with, work hitherto left to the division superintendents.

Mr. F. E. Ward, General Manager of the Chicago, Burlington & Quincy R.R. lines east of the Missouri River, has announced that he will resign Sept. 1. Mr. Ward has completed 31 years of continuous railway service. He was formerly General Superintendent of the Montana Central Ry., and later General Superintendent and General Manager of the Great Northern Ry.

Mr. W. G. Brownlee has resigned his position as General Transportation Manager of the Grand Trunk Ry., and the office has been abolished. The work of this department will hereafter be handled by the office of the Vice-President in charge of transportation. Mr. Brownlee was formerly Superintendent of the Missouri Pacific Ry. at St. Louis, Mo., and went to the Grand Trunk Ry. in 1900 as Assistant Superintendent at Belleville, Ont.

Mr. George G. Honness, Assoc. M. Am. Soc. C. E., Division Engineer of the Board of Water Supply, City of New York, has been promoted to be Department Engineer, succeeding Mr. C. E. Davis, M. Am. Soc. C. E., whose resignation was noted in our issue of July 25. Mr. Honness is a graduate in civil engineering of Lafayette College, and previous to his work with the Board of Water Supply was with the engineering department of the Passaic Water Co., of Paterson, N. J.

Mr. Thornwell Fay, President of the Galveston, Harrisburg & San Antonio Ry., the Houston & Texas Central and the Texas & New Orleans R.R., has announced his intention to resign on Sept. 1. Mr. Fay began railway work nearly 35 years ago, at the age of 17 years, as a telegraph operator on Morgan's Louisiana & Texas R.R. & Steamship Co. Since then he has been continuously in the service of this railway and various other southwestern subsidiaries of the Southern Pacific Ry.

Mr. Thomas Coltrin Keefer, Past-President of both the American and the Canadian Societies of Civil Engineers, and one of the oldest and best known engineers in America, has been elected an honorary member of the Institution of Civil Engineers of Great Britain, in recognition of the distinguished part he has taken in the engineering enterprises which have aided so largely the development and prosperity of Canada, and on account of the services he has rendered to the engineering profession during his long association with it. Mr. Keefer will be 91 years old on Nov. 4. He began his engineering career in 1838 on the Erie Canal. Later he was Division Engineer in the building of the Welland Canal. In 1845 Mr. Keefer was Chief Engineer of the Ottawa River improvement work. Six years later he made preliminary surveys for the Grand Trunk Ry., and his influence was largely responsible for the abandonment of the then Canadian track gage and the adoption of the standard gage then in use in New England and New York. He was Engineer for the design and construction of the waterworks of Montreal, Hamilton and Ottawa, and was prominent in the inception and ultimate construction of the Canadian Pacific Ry. He was the first President of the Canadian Society of Civil Engineers, and served again in that office in 1897. Mr. Keefer is a Companion of the Most Distinguished Order of St. Michael and St. George, an officer of the Legion of Honor of France, and has been the recipient of many other honors. A more complete biographical sketch of Mr. Keefer was published in our issue, Jan. 21, 1889, at the time of his election as President of the American Society of Civil Engineers.

Obituary

Henry F. Donaldson, President of the Society of Automobile Engineers, committed suicide on Aug. 13, at his home in New York City.

Rowan Ayres, reported in press dispatches as an American civil engineer, was killed by the Mexican rebels on Aug. 14, near Morelia, Mex.

Capt. Frederick A. Hinman, Corps of Engineers, U. S. A., retired, died at his home in Flushing, New York City, on Aug. 16. He graduated from the Military Academy at West Point in 1867 and was retired from active service in 1891 because of disability incurred in the line of duty.

R. M. Sulley, an engineer officer of the Confederate Army during the Civil War and later connected with the reconstruction of several Southern railways, died at his home in Petersburg, Va., Aug. 15, at the age of 77 years. For many years he was Superintendent of the Atlantic Coast Line Ry.

William Stickney Lamson, inventor of cash carriers for stores and various package handling devices, for many years Treasurer of the Lamson Consolidated Store Service Co., of New York and Boston, died at his home in Lowell, Mass., Aug. 16. Mr. Lamson was also President and General Manager of the American Mason Safety Tread Co., of Lowell. He was 66 years old and leaves a widow and two sons.

T. B. McClintic, Passed Assistant Surgeon, United States Public Health and Marine Hospital Service, died, Aug. 13, from "Rocky Mountain spotted fever." For the past two years, Dr. McClintic had been investigating this deadly and mysterious malady, which is transmitted by a species of wood tick found in the Bitter Root Valley, Montana. Dr. McClintic was 39 years old and had been married but a few weeks previous to his death.

Edmund M. Wheelwright, a well known architect of Boston, Mass., died on Aug. 15. He was born at Roxbury, Mass., in 1854 and graduated from Harvard University in 1876. He studied architecture at the Massachusetts Institute of Technology and in Europe, after which he entered the employ of Peabody & Stearns, of Boston. In 1883 he went into business for himself and later founded the firm of Wheelwright, Haven & Hoyt. From 1891 to 1895 he was City Architect of Boston and designed the City Hospital and other municipal buildings. Since 1900, when he was engaged to design the architectural features of the Cambridge Bridge, he had become one of the most notable bridge architects of the country. Mr. Wheelwright was Consulting Architect for the great arch bridge across the Connecticut River at Hartford, Conn., completed four years ago. He was a fellow-member of the American Institute of Architects, a member of the Boston Architectural Club and was the author of several books on architectural subjects.

Channing F. Meek, former railway official and President of the Colorado Yule Marble Co., Marble, Colo., died on Aug. 14, as a result of injuries received a few days previously in a tram-car runaway at the company's quarries. The accident occurred when Mr. Meek and several others were bringing a new motor car from the quarry to the town. The car got beyond control and those on it were compelled to jump or remain to face the dangers of derailment on a sharp curve. Mr. Meek was born at Mount Pleasant, Iowa, in 1855. He began a railway career as a telegraph operator with the Chicago, Rock Island & Pacific Ry., later becoming Chief Dispatcher. In 1882 he was appointed General Superintendent of the St. Louis, Des Moines & Northern R.R., and in 1887 was General Manager of the Denver, Texas & Fort Worth R.R., which later became the Union Pacific, Denver & Gulf R.R. (now the Colorado & Southern Ry.) He left this position in 1891 and went to Mexico where he was interested in various enterprises. Mr. Meek founded the Colorado Yule Marble Co., in 1900 and had developed an extensive business during the past 10 years.

Engineering Societies

COMING MEETINGS

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
Aug. 26-30. Annual convention at Peoria, Ill. Secy., Clarence R. George, Houston, Tex.

TRAVELING ENGINEERS' ASSOCIATION.
Aug. 27-30. Annual convention at Chicago, Ill. Secy., W. O. Thompson, N. Y. C. car shops, East Buffalo, N. Y.

INTERNATIONAL CONGRESS FOR TESTING MATERIALS.
Sept. 2-7. Sixth congress at New York City. Secy. of organizing committee, H. F. J. Porter, 29 West 39th St., New York.

INTERNATIONAL CONGRESS OF APPLIED CHEMISTRY.
Sept. 4 at Washington.
Sept. 6-13 at New York City. Secy., Bernhard C. Hesse, 25 Broad St., New York.

AMERICAN ELECTROCHEMICAL SOCIETY.
Sept. 7-10. Annual meeting at New York City. Secy., Jos. W. Richards, Lehigh University, South Bethlehem, Penn.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES.
Sept. 9-12. Annual meeting at Hot Springs, Va. Asst. Secy., Walter Neumuller, 55 Duane St., New York.

ROADMASTERS' AND MAINTENANCE OF WAY ASSOCIATION.
Sept. 10-13. Annual meeting, Buffalo, N. Y. Secy., L. C. Ryan, C. & N. W. Ry., Sterling, Ill.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.
Sept. 10-13. Annual convention at Denver, Colo. Secy., A. P. Dane, B. & M. R.R., Reading, Mass.

ILLUMINATING ENGINEERING SOCIETY.
Sept. 16-19. Annual convention at Niagara Falls, Canada. Secy., P. S. Millar, 29 West 39th St., New York.

PACIFIC COAST GAS ASSOCIATION.
Sept. 17-19. Annual meeting at San Diego, Calif. Secy., John A. Britton, 445 Suter St., San Francisco, Calif.

NEW ENGLAND WATER WORKS ASSOCIATION.
Sept. 18-20. Annual convention at Washington, D. C. Secy., Willard Kent, Narragansett Pier, R. I.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Sept. 18-20. Annual meeting at Washington, D. C. Secy., Selskar M. Gunn, 755 Boylston St., Boston, Mass.

INTERNATIONAL CONGRESS ON HYGIENE AND DEMOGRAPHY.
Sept. 23-28. Fifteenth congress at Washington, D. C. Secy., John S. Fulton, Senate Annex, Washington, D. C.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
Sept. 24-26. Annual convention at Buffalo, N. Y. Secy., R. D. Moldenke, Watchung, N. J.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.
Sept. 26-28. Annual convention at Indianapolis, Ind. Secy., R. C. Harris, City Hall, Toronto, Ont.

NATIONAL IRRIGATION CONGRESS.
Sept. 30-Oct. 3. Annual meeting at Salt Lake City, Utah. Secy., Arthur Hooker, Salt Lake City.

AMERICAN ASSOCIATION FOR HIGHWAY IMPROVEMENTS.
Sept. 30-Oct. 5. Annual convention at Atlantic City, N. J. Secy., G. E. Pennybacker, Jr., Colorado Bldg., Washington, D. C.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 7-11. Annual convention at Chicago, Ill. Secy., H. C. Donecker, 29 W. 39th St., N. Y. City.

RAILWAY SIGNAL ASSOCIATION.
Oct. 8-11. Annual Convention at Quebec, Canada. Secy., C. C. Rosenberg, Times Bldg., Bethlehem, Penn.

AMERICAN RAILWAY BRIDGE & BUILDING ASSOCIATION.
Oct. 15-17. Annual convention at Baltimore, Md. Secy., C. A. Lichty, 226 Jackson Blvd., Chicago, Ill.

AMERICAN GAS INSTITUTE.
Oct. 16-18. Annual meeting at Atlantic City, N. J. Secy., Geo. G. Ramsdell, 29 West 39th St., New York.

Maine Society of Civil Engineers—A meeting of the Society was held on Aug. 14-15, and papers were read on hydraulic development and on the cost of steam power.

American Society of Civil Engineers—A meeting of the Board of Directors of the San Francisco Association was held on Aug. 16, followed by the regular bimonthly meeting of the Association. A paper entitled "The New Drawbridge of the Northern Electric Company, at Sacramento, California," was read by A. H. Markwart.

American Society of Engineer Draftsmen—The August meeting of the Society, held Aug. 15, in the Engineering Societies building, was well attended. A paper entitled "Safety Devices—Their Application and Design," by W. T. Walters, and a lecture on "Practical Perspective," by Prof. C. W. Weick, were given, followed by discussion on the proper method for dimensioning drawings. The secretary of the Society is Walter M. Smyth, 116 Nassau St., New York.

Connecticut Society of Civil Engineers—The midsummer meeting of the Society was held on Aug. 21 and consisted of an inspection trip to the Harbor of Refuge at Duck Island. There are three breakwaters in process of construction at this location, involving the placing of about 392,000 long tons of rock, and a total expenditure of about $460,000. This harbor is half way between those of New Haven a..d of New London, and it is a big factor in safeguarding vessels on Long Island Sound.

Chamber of Commerce of the U. S. A.—The Bridge Builders' Society of New York has recently been elected to membership in the above mentioned association. This national chamber, organized in April, 1912, has already affiliated with it over 7,000 business men, members of 102 different associations, covering 29 states and the Hawaiian Islands. The headquarters of the chamber are located at 707 Riggs Building, Washington, D. C., and Elliot H. Goodwin is the general secretary. A paper called "The Nation's Business" is published, edited by G. Grosvenor Dawe.